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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

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ANOTHER METALLIC FILAMENT LAMP.

Another attempt to substitute a metal for carbon in the incandescent lamp has reached the patent stage. This filament is the result of the combined efforts of two Austrians, Dr. Alexander Just and Herr Franz Hanaman. The inventors have secured commercial relations with a German firm, and have patented the new filament in Great Britain.

This particular filament, while resembling in some respects the one recently referred to in the ELECTRICAL REVIEW for March 3, as the invention of Dr. Kusel, differs from it in that another metal is employed, the material in the newer lamp being tungsten, or, as it is called in Germany, wolfram, a metal related to molybdenum and uranium. The chief sources of this metal are wolframite, a mineral found in the Cornish tin mines and elsewhere in Europe, and in the United States.

From the descriptions at hand the process of manufacturing the lamp is not made perfectly clear. It seems, however, that a start is made with a carbon filament which is coated with tungsten by heating the filament in a vapor of tungsten salts. The metal is deposited upon the carbon, forming a carbide, and the action, which is carried on in a highly exhausted chamber, or even *in vacuo*, is allowed to proceed until all the carbon of the filament is either converted into carbide or dissolved in this compound. By watching the current flowing through the filament it can be determined when this stage is reached. The success of the process seems to depend upon employing a fine filament, the diameter varying from two mils to three-quarters of a mil. The vapor employed is said to be preferably a high chloride of the metal, with which some reducing gas is mixed, such as hydrogen. After the coating has become sufficiently thick the filament is raised to incandescence by increasing the current, when the coating of the metal is converted into the carbide in a very short time. This process is carried on in an inert atmosphere. The filaments at this stage are said to be white and have a metallic appearance.

The next stage of the treatment is to get rid of the carbon by oxidation. This is done by heating the filament again to incandescence and introducing an oxidizing agent, such as steam, mixed with some reducing agent. The carbon is oxidized and the gases carried off. It is said that a similar result can be accomplished without oxidation simply by heating the filament to an exceedingly high temperature in a high vacuum until the carbon is volatilized.

Other methods of decarbonizing may be employed, though none of them seems to be as simple as the two described. The filament is said to be ready for making up into lamps as soon as the carbon is completely driven off, no flashing or other similar process being necessary.

So far no figures showing the performance of this lamp have been published and no estimate is given indicating its relative cost with respect to carbon. However, every suggested solution of the lamp problem which offers any prospects of success is of value, as it forms one step at least in our progress toward a more efficient incandescent lamp.

It is interesting to note that in this new process of manufacturing incandescent filaments carbon is used, which is converted into carbide and then reduced to the metal, the carbon being driven off. This recalls the Völkner filament, proposed some years ago, which was said to give excellent results, although in the latter filament the process was stopped at the carbide stage, the filament consisting either of a carbide of some metal or a carbon core coated with such a carbide.

A PHASE OF HYDROELECTRIC DEVELOPMENT.

An interesting point was made by Signor G. Semenza in a recent paper read before the Society of Civil Engineers, of France, in which he described the hydroelectric installations of Italy, which paper was abstracted briefly in the ELECTRICAL REVIEW for April 28. The author pointed out that Italy occupies a peculiar position in regard to hydroelectric development, since, as she has almost no fuel supplies, her steam power stations are dependent upon imported coal, which is not only costly, but the supply of which may at times be uncertain. Under such conditions it is entirely proper to utilize the water power to its fullest extent, and to install machinery having an output greater than that available when the flow of water is least. Under such conditions, the excess machinery will lie idle a considerable part of the year, and will thus be bringing in no income, although it will entail a constant expense both for care, maintenance and interest on the investment; that is to say, the load-factor of the station will be low. This practice is only allowable in countries situated as Italy, where the cost of power is necessarily somewhat high.

It is possible, of course, in many cases to improve the condition by the use of some storage system, preferably reservoirs, in which the water, in times of flood, may be caught and held. This system is used in Italy wherever available, but it was the installation of machinery to utilize that part of the flood which could not be stored up, or the high water at such installations which have no storage reservoirs, to which Signor Semenza referred. Power of this kind is necessarily somewhat intermittent, though it will probably all be available during a definite period of the year; but it seems to create a distinct problem to dispose of it. There are very few hydroelectric plants which sell every kilowatt-hour they can produce, and there are still fewer which would be able to dispose of power of an uncertain amount which may be produced at any time within a certain period. Some of this intermittent power might be stored up for a short while for future use, but it could not be held long. Storage batteries would only be useful for holding a comparatively small amount of power, and that only for a few days. They would be suitable if the floods occurred daily, or possibly weekly, but under no other conditions; and, moreover, they would necessitate the installation of a good deal of additional and expensive apparatus.

The only way that would seem to be suitable for utilizing this extra power would be to apply it to industries which can be operated intermittently. There might, for instance, be erected near the power-house carbide furnaces or other electrometallurgical or electrochemical plants; but since the conditions would make the load-factor at these plants poor, and they would be forced to remain idle, or at least operate at a small output during the greater part of the year, the conditions would not be altogether suitable for success. Thus the suggestion does not seem to be very alluring, although further explanations may put the matter in a little more favorable light.

A somewhat allied problem in hydroelectric development was brought out in a recent issue of *L'Industrie Électrique* by M. Henri Bresson. He points out that the glacial streams of France and Italy have been largely developed for electrical generation, and then calls attention to the fact that the flow of water in these streams is greatest during the warm months, when there is least demand for current for lighting. From this it follows that the slow-running navigable streams of France, which depend principally upon rains for their supply, are more suitable for electric light stations than the glacial streams, for the flow of water in them is greatest during the winter. To make use of this condition it will be necessary to install machinery having an output greater than that which would be available during the months of least flow. A lighting load is naturally greater during the winter than during the summer, though the peak of the load may not differ so greatly. A comparatively small reservoir would, however, suffice to carry over this peak in the summer, so that the station could properly install machinery to utilize the extra flow of water during the winter; but this condition hardly obtains in northern Italy, the section to which Signor Semenza devoted his attention, although he may have been considering the matter in a larger light when he made his statement.

A NEW ELECTRICAL TRANSPORTER.

A new and ingenious method of handling materials in shipbuilding has been adopted at Jarrow, England, by the Palmer company. It was desired to erect a system of handling material which would not only carry it to the vessel undergoing construction, but would be available for holding the material while it was being put in place on the ship. Several solutions of this important problem have been sought, some using a large number of jib cranes, others employing a number of overhead traveling cranes, such as are used commonly in power plants and manufacturing works; but neither of these plans seemed to be altogether desirable. What was wanted was a system which would cover an area about 500 feet long and 100 feet wide, which would reach any point in this area, yet which would not take up a large amount of valuable ground space. The solution finally decided upon was an adaptation of the overhead cableway. Two large cross-girders were erected at the ends of the area to be covered, being supported on lattice-work columns properly guyed. From these girders were suspended three large steel cables, upon which travel three trolleys. These trolleys, of course, give longitudinal motion from end to end of the area, and to secure the necessary lateral motion it was necessary to arrange the cables so that they could be traversed. This was done by suspending each of the cables from two traversing carriages, one carriage being, of course, mounted on ways on each girder. Each pair of carriages can be moved simultaneously along the girders by means of electric motors, controlled from the operator's stage on the trolley. Further, the trolley itself is moved along the cable, and the hoisting is done by means of an electric motor, all these motions being controlled by one man, who is stationed directly over the load which he is handling.

This solution of the problem is striking because of the means adopted for obtaining lateral movement. Two carriages, connected merely by flexible ropes, and running on ways 500 feet apart, must be controlled so as to move and stop simultaneously from an intermediate point. This can be accomplished at the present day only by means of the electric drive; in fact, the entire system is a noteworthy adaptation of electrical control.

AN EARLY SPRING CROP.

Somehow it seems as if the opening of spring affects the imagination of certain individuals, for at this season the inventor's fancy turns lightly toward the investor's pocket. It may be that the quiet of the winter is conducive to the perfecting of plans for getting the use of someone else's money, and that the cheerfulness and optimism which the spring season engenders make the labor of doing this light. In any event it always seems as if the coming spring is accompanied by an increase in the outpour of circulars and advertisements intended to attract those who have any money to invest. Needless to say, many of these schemes are not only legitimate, but are good and probably as safe as any form of investment, but there are others which can hardly be described by any more dignified term than "fake," and it is these which offer the most dangerous pitfalls for those with small savings. Such persons are apt to be rather ignorant in regard to the scientific and technical possibilities of any device, and they are not likely to know that oftentimes the plan proposed is an old one and has long since proved to be utterly impracticable. Moreover, these people, as a rule, can not afford to have an investigation of the device made by a competent expert, and they thus are left at the mercy of the rascals who are merely trying to get something for nothing. It is well always to be on one's guard against such schemes, and one should never rely wholly upon what the schemer says. If he be honest he will court investigation and not try to confuse, so that one need never be afraid of offending by asking questions; and it is always better to display a little ignorance at first and thereby save one's savings than later on to lose all and thus be shown to be a goose.

It is also well to question the sincerity of one who poses as the inventor of some notably successful machine or system, if his name be not familiar. In these days the man who does a good thing can not easily remain out of the public eye, and if any one never heard of before poses, for example, as the inventor of the electric trolley system, it does no harm to doubt a little until his assertions can be verified, which should not be difficult to do. Then, again, if any one states that he has solved a problem which has baffled the scientific and technical world for years, his success will be made known in other ways besides advertisements and circulars spread broadcast. The inventor of a revolutionizing appliance can not to-day keep out of the papers, and although a good many cranks do get advertising through the newspapers, a valuable device or system will not be lost sight of in a day. On the other hand, sensational writing and large type will not make the wheels go round. It remains for the man who claims that he has solved the problem of perpetual motion to prove that merely increasing the length of his levers and the size of his weights will make the machine run. The possible investor should not be satisfied with the contradictions of good authority, but should demand proofs; and the more vehement the denunciation of the pure scientist and book-worm, the more should one insist upon being shown.

Along with the inventors of impossibilities, the spring also brings wonderful treatises, in which the profoundest scientific problems are discussed with an ease and conviction that at least excite our admiration, although they do not convince. Such treatises do no harm, if it be not to those who are foolish enough to send them out, and they frequently give the recipient a quarter of an hour's enjoyable reading.

STANDARDIZING ELECTRIC CABLES.

The recent meeting of the American Institute of Electrical Engineers was devoted to the reading and discussion of two papers on insulated cables. The first of these dealt with the smaller problem of standardizing rubber-covered wires; the other called attention to some undesirable features of the present method of constructing such cables. Both papers offered specifications for high-grade rubber-insulated wire.

The discussion took a rather broader trend. Those participating seemed to feel that the whole question of high-tension cables was up for consideration. It was from this viewpoint that the excellent suggestion was made, that specifications for a high-tension cable should deal rather with what the cable should do than with the methods of manufacturing. When one is buying a dynamo or motor transformer he is satisfied to let the manufacturer build it as he pleases, provided the apparatus does what it is intended to do. This same method should be followed when purchasing cables calling for a certain result, unless the engineer wants a particular kind of cable. If he be simply looking for a satisfactory performance of two equally good cables the cheaper one is the better, and it should be immaterial to him whether the insulation be rubber, cambric, paper or anything else.

The problem, however, is not so simple as that of selecting a dynamo or motor. We can not always predict how a cable will behave from such tests as can be applied when it is purchased. In fact, a good part of the discussion during the meeting was given up to the proper methods of testing; and here there was a considerable difference of opinion. As long as this condition exists the purchaser of rubber-insulated cables will probably specify that the insulation contain a certain percentage of high-grade rubber in addition to demanding that the finished product shall withstand successfully certain tests. Such a purchaser must then in his specifications insert such requirements as will enable him to determine whether the required amount of rubber has been used, and since there seems to be some uncertainty about the reliability of these tests, it would be well to make use of several in order that the results of one may be confirmed by those of the others.

What we need is to know more about the various kinds of insulating material we use. We should be able to predict the performance of any grade of insulating material, prepared in a definite way, from a few well-conducted tests. At the present time there is always some uncertainty; we can not say what will be the breakdown voltage of the cable until we actually measure it, and, unfortunately, the very act of doing this is apt to spoil the cable. There is a large field here for some well-conducted investigations. We seem now to be working pretty much in the dark. We recognize certain materials as good insulators, and we demand that they be used and that they be put through certain arbitrary tests. Any one who can reduce the subject to a more scientific basis will perform a valuable service for the electrical industries.

The Overhead Wire Cableway Applied to Shipbuilding.

At a recent meeting of the Institution of Naval Architects, of Great Britain, a paper was read by Mr. J. L. Twaddell on the use of overhead wire cableways in shipbuilding. In the construction of steel vessels mechanical methods of handling material are widely used up to the vessel itself; then it frequently happens that older, primitive methods are employed for placing each piece where it belongs. The opinion has been frequently advanced that if a sufficient number of jib derricks were installed on each side of the construction work, the requirements would be met; yet practice has shown this to be insufficient, for it is customary to lay, in addition, a light railway on the deck of the vessel as early as possible in order to transport material in a fore and aft direction after it has been dropped on board. Another objection to the derrick system is the necessity of maintaining clear roadways at the sides of the berth for the delivery of material to the derricks.

An overhead wire cableway is free from many of these objections, but the ordinary type as employed in excavation could not be used without modification, since it serves only a narrow track beneath it. That such a modification can be made and the system changed to suit shipbuilding conditions is due to the flexibility and mobility of electric power, and a system of this kind has been installed by the Palmer Company, at Jarrow, England. It was decided to erect a system capable of carrying a safe load of three tons, and that there should be three units; that the rectangle to be covered by the transporter should be 500 feet in length and 100 feet wide. The structure was made strong enough for a fourth unit, but experience has shown that three is all that is necessary.

The system, in brief, consists of three cableways suspended lengthways over the building berth and carried at each end on specially designed cross girders placed transversely one at each end of the berth, each supported about 100 feet above the ground by two inclined lattice steel columns. Each of these girders is constructed in two parts, with a clear space between to admit the passage of the cable for transverse movement. This system takes up but little ground area. The four columns are supported on foundations sixteen feet by sixteen feet. From the heads of each of the four supporting columns are two adjustable back guys of steel wire, six and one-half inches in circumference, dropping vertically, and secured through stretching screws to an anchorage of solid concrete. The height of these columns is designed to give the trolley cables the same declivity as the ground, irrespective, of course, of sag. The sag is about eighteen feet. The fall toward the river is advantageous, since gravity thus assists in carrying material to its destination and the return journey up hill is made unloaded.

The transverse movement of the cable is obtained by carriages at each end, which travel on rails on the fore part of the forward girder and the after part of the after girder. These carriages are built of steel and are traversed by a twelve-horsepower enclosed, reversible motor geared through worm and spur-gearing to two axles carrying the rail wheels. The trolleys are constructed of steel, with a cage for the operator. Each carriage contains a thirty-five-horse-power enclosed reversible and ventilated motor, which provides power for hoisting and traveling motions. Current is conveyed to the motor from overhead electric copper cable suspended between the supports, suitable collecting arms and connections being attached to each carriage. The longitudinal traveling motion is obtained through friction and spur-gearing from the motor to the travel motion shaft, on which two traveling rope drums are keyed, one at each end. The two traveling ropes are stretched from end to end of each cableway, each being wound on its drum a sufficient number of times to prevent slipping.

Two controllers, with resistances, are fitted on each carriage, one for controlling the motor on the load carriage and the other for the motors on the two traversing carriages. Overhead copper cables carrying the current are attached to steel spiral springs mounted in compression. There is a special cutout arrangement which will disconnect the wire instantly should it break. The carriage travels longitudinally 600 feet a minute, and hoists three tons at 100 feet a minute and one ton at 150 feet a minute, and traverses twenty-five feet a minute. In practice 400 feet per minute for longitudinal travel is found to be sufficient.

Electric Road Receipts.

At the annual meeting of the board of directors of the Public Service Corporation of New Jersey, held in Newark, N. J., May 1, the reports of the receipts of roads owned and operated by the company showed a marked increase over the receipts of the previous fiscal year. The gross receipts of the North Jersey Street Railway Company showed the heaviest earnings, being $5,141,917, an increase over the previous year of $287,464. The leased lines showed an increase of $122,601 in gross receipts; their total receipts were $1,548,728. The Jersey City, Hoboken and Paterson system, which is known as the White Line, showed a large increase in net receipts. The gross receipts were $2,359,899, being an increase of $190,885.

National Electric Light Association.

It is announced that applications for space for exhibitions at the convention of the National Electric Light Association, to be held at Atlantic City, N. J., June 5 to 8, have been coming in so fast that it is likely that the main hall of Young's Pier will be entirely occupied and overflow exhibits will be held in the pier wings. The exhibit of central station advertising material by the committee on progress promises to be very large and to embrace a number of new features.

The uniform plan of exhibit and booth decoration is found to lend itself admirably to the space provided, and the lighting and color scheme will prove effective.

While the convention is going on the entertainment features on the pier will consist of musical concerts, a vaudeville theatre, a skating rink and deep-sea fishing.

New York Electrical Society.

The New York Electrical Society held its 258th meeting at the Edison auditorium, 44 West Twenty-seventh street, Wednesday, April 25. The address of the evening was on the subject of "News, Newspapers and the Telegraphic Art," by Melville E. Stone, general manager of the Associated Press. In view of the interest in the disastrous earthquake and fire at San Francisco, the officers of the society supplemented this with special addresses bearing on the catastrophe. President Barstow gave a sketch of the remarkable power transmission developed in California, for which San Francisco is the focal point, and Dr. F. A. C. Perrine, speaking on the same subject, showed on the screen some of the most interesting points of these installations, together with many of the buildings in San Francisco which have been destroyed. Mr. Stone gave a lucid and eloquent exposition of the development of news gathering and of the extraordinary achievements which telegraphy now renders possible.

The following members were elected: Charles N. Green, A. E. Mitchell, Baychester, N. Y.; Alex. Cameron, Brooklyn, N. Y.; Frederic A. Coolidge, Yonkers, N. Y.; Archer M. Huntington, Leigh S. Keith, A. A. Gray, Dr. Emil Heuel, S. S. Dickinson, C. B. Fairchild, Jr., New York city.

American Institute of Electrical Engineers.

The 206th meeting of the American Institute of Electrical Engineers was held at the Edison auditorium, New York city, on the evening of Friday, April 27. The first paper to be read was by Mr. John Langan, of New York city, and was entitled "Standardizing Rubber-Covered Wires and Cables." This paper will be found on another page of this issue.

The second paper was entitled "Comments on Present Underground Cable Practice," by Mr. W. S. Clark, of Schenectady, N. Y. The author first criticizes certain practices prevailing in underground cable work, dwelling particularly upon the disadvantages of a continuous conducting sheath surrounding the insulation of the cable. This sheath aggravates matters in case of damage to the cable, and may also assist in heating the insulation. These objections can be overcome by omitting the sheath. This will prevent the use of such materials as paper, which are affected by moisture. He thinks that if a lead sheath is to be used it should be frequently interrupted by insulating joints, and a test wire should be run in the cable for proving the insulation. A metal sheath is less objectionable on high-tension cables, and there is less need for insulating joints.

With respect to the insulation of the cable, the thinner this can be the better, provided, of course, the dielectric strength be sufficient. The author believes that in the present state of the art a reasonable amount of good rubber is necessary to ensure durability. He gives a list of some of the cable troubles which the Cataract Power and Conduit Company, Buffalo, N. Y., has had. This shows that although most of the cable there employed has been in use for eight years, there is no indication of any electrochemical or other action weakening the ability of the insulation to stand the working pressure.

Mr. Clark gives a brief set of specifications for a thirty per cent rubber insulating compound. These call for chemical, mechanical and electrical tests. The purchaser may also send an inspector to the works to see the insulation made, so as to assure himself that thirty per cent of pure rubber has been used. He shall not, however, be privileged to enquire into the other ingredients employed.

The discussion was opened by Mr. Henry W. Fisher, Pittsburg, Pa., who disagreed with Mr. Langan in some points. Mr. Fisher thinks that the voltage test for dielectric strength is useful, as it helps to throw out inferior compounds. He does not think that rubber is the best insulating material for all conditions, nor is rubber indestructible, as it certainly deteriorates even under normal atmospheric conditions when placed out of doors. He would prefer to have the dielectric resistance test of the cable made after the braid has been applied. Mr. Fisher, however, believes that the voltage tests recommended by Mr. Langan are too low, and that higher tests can be made without damaging the insulation. With the proper kind of insulation the rise in temperature during a high-voltage test should not be sufficient to damage the rubber. It was pointed out that the high-voltage tests recommended by Mr. Clark were fifty per cent greater than those recommended by Mr. Langan. There is no objection to using reclaimed rubber for low voltages, say not over 5,000. There is little difference between testing a lead-covered paper cable and a rubber cable immersed in water, so far as the strain on the dielectric is concerned. It does not seem probable that the pressure wire suggested would be entirely satisfactory for indicating the condition of the insulation.

Mr. H. G. Stott, New York city, exhibited a good number of samples of rubber-covered wire, and gave the results of many tests on them, illustrating them by means of diagrams. These tests were thought to show that the variation of the insulation resistance or change of temperature was the best check on the amount of Para rubber in the compound. The puncture test is often helpful, but not absolutely. The stretching test is absolutely unreliable. Mr. Stott further said that he did not put much confidence in the chemical tests.

Mr. Philip Torchio, New York city, thought that it was very desirable that a cheap insulation should be employed for certain classes of work; that it is not advisable to demand thirty per cent Para rubber in the insulation of all low-tension wires. For such wire the dielectric strength and insulation requirements are of secondary importance to durability and life. The high-tension cable, on the other hand, requires high dielectric strength and moderately high insulation resistance as well, as durability and life under conditions of temperature are sometimes very severe. What is sought is to secure durability first for all classes of wire, and second, moderately high insulation resistance and high dielectric strength for high-tension cables. Mr. Torchio does not think that a thirty per cent Para rubber insulation is the best for all rubber-insulated wires, as less may be used under certain conditions, and the same durability be obtained. Some doubt was expressed as to the reliability of the acetone extractive test. Mechanical tests have been called for by the United States Navy, where a forty per cent pure Para rubber is used. These tests give valuable information, but are not sufficient alone. The elongation test may be greatly affected by improper vulcanizing. It was suggested that the matter under discussion be taken up by a special committee of the Institute, which should collect data from all parts of the world.

Dr. A. E. Kennelly, Cambridge, Mass., thought that the basis of the whole matter, from an engineering standpoint, is the breakdown test. A point which seems to have been overlooked is that when a cable is stressed the inside layers are more severely strained than the outside, and the action may result in permanent injury to the insulation.

Mr. E. W. Stevenson, Wilkesbarre, Pa., differed in some points with Mr. Langan. He does not see why the pressure test is no criterion of a good insulation. If a doped material gives good results and lasts well, it is just as good as anything else. However, this pressure test should not be made alone, but other tests are equally necessary. The mechanical tests are of the greatest importance and should always be called for by the purchaser. The chemical test is good, provided it is made by one familiar with the test. There seems to be a lack of agreement in Langan's tables for testing voltages, higher voltages being called for in some cases than in others, though the conditions are practically the same. While admitting that a high quality of Para rubber has a high dielectric resistance, there is no proof that a high dielectric resistance in megohms per mile indicates a compound of first-class quality. On the other hand, an excellent article may be turned out, although the dielectric resistance is comparatively low. The speaker suggested a modification of the formula at present used for determining dielectric resistance in megohms per mile. Excessive pressure tests are unnecessary and dangerous, but it is safe within the limits to apply a test of two and one-half times the working pressure.

Mr. Townsend Wolcott, New York city, said that the United States Signal Corps found the best way to be sure of getting the rubber compound called for was to have an inspector at the works. The acetone test is somewhat uncertain, since rubber is not a definite chemical compound.

Professor Durand Woodman thought that when a final set of specifications is drawn up it will call for chemical, mechanical and electrical tests. The chemical

test is easily made and does not take a long time, and it gives valuable information.

Mr. William McClellan, Philadelphia, Pa., thought that the chief difficulty in selecting a cable is in deciding upon its durability. At the present time rubber seems to be the only substance which can be confidently depended upon, but rubber alone will not provide a durable insulation. However, for a large proportion of the work that has to be done it is not necessary to call for thirty per cent of pure Para rubber, which would make the wire entirely too expensive. It is thought that the tests which had been discussed were only indicative and not absolutely reliable. The acetone test is positive for determining the quality of crude rubber, but can not be depended upon for rubber compounds, because the other substances themselves may be dissolved by the acetone. It is thought that this method of approaching the problem is wrong. Of course, there is no objection to a large percentage of extractive matter if the insulation be durable. A form was suggested for cable specifications. This should fix the conditions of the copper, the quality of the rubber, the quantity of pure rubber, the sheath, the testing and the packing. Such specifications would make possible the use of all qualities of rubber in all percentages and put the various tests where they belong, and would make sure that the purchaser gets what he calls for.

Mr. C. F. Scott, Pittsburg, Pa., thought that the discussion of the specifications looked upon the matter rather from the manufacturer's standpoint than from that of the constructing and operating engineer. What should be specified is performance, and not methods of manufacture. This should be left to the cable makers. An important point in deciding upon a test is to fix the time during which the high voltage will be employed. A cable during operation is not likely to receive a double voltage for a minute, but it is very much more likely to receive some very high voltage for a fraction of a second.

Mr. Fisher did not agree with Mr. Stott as to the value of the temperature change in determining the quality of the rubber compound; nor, as suggested, was it true that the voltage of the test battery affected the value of the insulation resistance, as found.

Replying to the discussion, Mr. Langan thought that it had taken a rather broad trend, as his paper had dealt with rubber-covered wires and cables. At the present time there is no standard practice in drawing up specifications. One engineer will prescribe a voltage test, another a tensile test, another a chemical test, and so on—there is no standard. He thought that Mr. Stott's curves upheld the opinions which were expressed in his paper. Before one can determine anything about a compound it must be submitted to a chemical analysis. The mere fact that the maker says it contains so much Para rubber should not be accepted without proof. Under favorable conditions the insulation resistance does indicate the character of the compound, for a high resistance can not be obtained without the use of Para rubber. The chemical test is valuable if carried out properly, and a mechanical test also assists in proving that Para rubber has been used.

Mr. Clark, in replying, did not agree entirely with Mr. Langan. He did not think it would be wise to require all rubber-covered wire to contain a high content of Para. It is wrong to assume that rubber is the only possible insulating material. It is the only elastic insulating material, but there are many mixtures which contain little rubber which are perfectly good for low-voltage service. He did not agree with the statement that rubber is unrivaled for all purposes, nor should too much dependence be placed upon a close figure in the extractive test, for the Para rubber of to-day is not so good as it was ten years ago. It now averages two per cent more extractive matter than it did then. The figures given in Mr. Langan's paper for voltage tests are too low, for there are cables now in operation at Niagara Falls which have been tested for one hour at 25,000 volts, which is higher than that allowed in the table given. While he would prefer to test rubber cables under water, there is no difference between this test and one with the lead sheath on. In regard to the point made by Mr. Stott that a compound containing only seventeen and one-half per cent of rubber had given better results than others containing higher values, it seemed to be merely a question of the method of manufacture; that with the higher compounds the test that could be done had not been done.

The meeting was then adjourned.

The Franklin Bicentenary.

The bicentenary exercises of the American Philosophical Society, celebrating the death of Benjamin Franklin, were held in Philadelphia, Pa., beginning Tuesday evening, April 17, and continuing until Friday evening of that week.

On Tuesday evening the exercises were opened by an address by President Edgar F. Smith, of the American Philosophical Society, at Witherspoon Hall. Following the presidential address the roll call of the delegates was announced, and the honorary degree of Doctor of Laws was conferred by Andrew Carnegie, as lord rector of the University of St. Andrews, upon Miss Agnes Irwin, dean of Radcliffe College. Miss Irwin is a great-granddaughter of Benjamin Franklin.

On Wednesday papers were read by Professor A. H. Lorenz, of Amsterdam; Professor E. L. Nichols, of Ithaca, N. Y., and by Professor Ernest Rutherford, Montreal.

On Thursday honorary degrees were conferred by the University of Pennsylvania, and an oration was made by the Hon. Hampton L. Carson.

On Friday addresses were made, and a presentation of the Franklin medal to the republic of France by the Hon. Elihu Root.

The exercises included the laying of a laurel wreath on the grave by the governor of the state of Pennsylvania, and by representatives of the president of the United States, the University of Pennsylvania, the Philosophical Society and the Pennsylvania Hospital.

An Appreciation of the Telegraph Operator.

Speaking of the work done by telegraph men in connection with the San Francisco disaster, Mr. W. H. Baker, vice-president and general manager of the Postal Telegraph-Cable Company, says:

Telegraph operators have always shown the highest self-sacrificing spirit, faithfulness and great physical endurance in times of public disasters and calamities, in pestilence and in war. I desire, through the papers devoted to telegraphers, to testify to the loyalty of our men in San Francisco, who with little sleep, scarcity of food and water, and, in some cases, without knowledge of the whereabouts and safety of their families, heroically stood by the company, realizing the great importance of their work, and that without their assistance all agencies for relief and restoration of normal conditions would be, at least temporarily, at a standstill. The various forces, civil and military, and all humanitarian efforts were practically dependent upon the work of the earnest, faithful and patient telegraph operator. Our men stood by us loyally, without any promises of reward, simply doing their duty and doing it willingly and conscientiously. Not only the force at San Francisco, but all employés throughout the service, have stood to their posts regardless of self-interest and at the cost of personal comfort, and have worked hard and efficiently to maintain the lines and move the traffic. We are proud of our men.

Berthoud-Thoune, Switzerland, Three-Phase Electric Road.

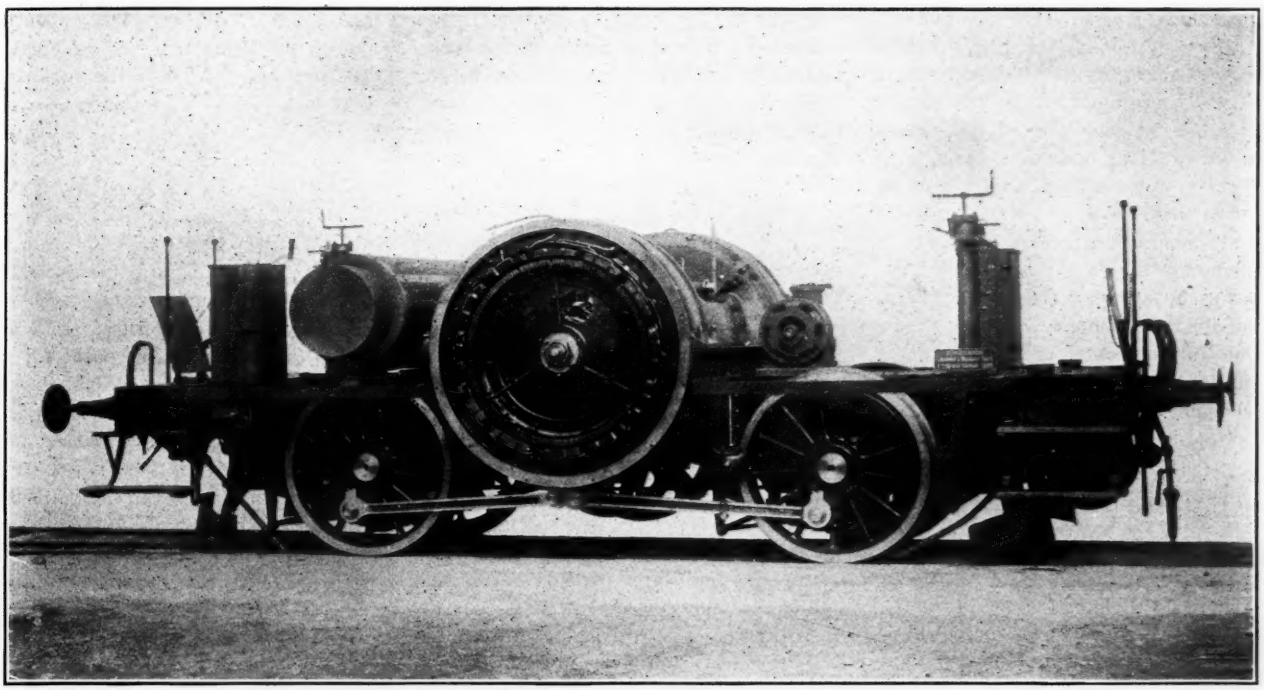
By C. L. Durand.

ONE of the most interesting of the three-phase electric roads which are now in operation on the Continent is the standard gauge line running between the towns of Berthoud and Thoune, Switzerland, over which there is already a considerable traffic. The new road has been constructed in order to secure a direct connection between the north and east region of Switzerland on the one hand, and the Bernese Oberland on the other, thus shortening up the distance considerably. The line starts from Berthoud and runs southward to Thoune, which lies on the lake of the same name. It passes through a picturesque mountain region and is now securing a considerable part of the tourist traffic. On its course it passes across several lines of railroad, among others the Jura-Simplon route, which runs from Berne to Lucerne. The northern terminus at Berthoud lies on the railroad line running from Zurich to Geneva *via* Berne, while the southern end of the line at Thun is situated on the railroad from Berne to Interlaken. The total length of the electric road is 40.28 kilometres (twenty-five miles). Along the line there are fifteen stations, of which four are the junction points with the above-mentioned railroad lines.

The use of the three-phase system was adopted in the present case, as it was found to be superior for several reasons. Here the line has a considerable length, and the trains were to have a maximum weight of fifty tons. At times where the traffic required it two such trains were to be coupled together, making a total weight of 100 tons. The speed of running was fixed at twenty to twenty-five miles an hour. As the new hydraulic station on the Kander, not far from the end of the line, was in erection, current for the road could be had from this source on the three-phase system. It was considered that the three-phase current would be the best to use upon the motors of the cars, seeing that this would dispense with the use of rotary converters along the route, these being replaced by simple transformer posts. Thus the first cost and the running expense is greatly reduced. The previous experience with the three-phase system showed that it could be very well used for operating the trains. In the present case the whole of the electrical outfit has been installed by the Swiss firm of Brown, Boveri & Company, to whom the writer is indebted for the following points relating to the new system:

The electric road employs the overhead trolley system and a standard gauge track. The trolley wire, which is double, is fed at 750 volts from the transformer posts. Current is supplied to the latter at 16,000 volts from the hydraulic plant. The trains are made up of a motor car and trailer, or by the use of electric locomotives.

The Berthoud-Thoune system uses a type of long motor car for the passenger traffic and an electric locomotive for the freight trains, both of which are here illustrated. The motor car will hold sixty-six passengers seated. In general, the train is formed of a motor car and a trailer of about the same capacity, and in times of heavy traffic the company adopts the system of coupling two trains of this kind together, giving a total capacity of 280 passengers. The size of the cars which have been adopted is somewhat larger than might be desired from the standpoint of economical running, but since the electric railroad makes connection along its route with no less than four lines of railway, the trains had to be made up to suit the nature of the traffic on the steam railroads. The electric trains are run in general at a speed of twenty-five miles an hour on a 2.5 per cent grade.



THREE-PHASE ALTERNATING-CURRENT ELECTRIC LOCOMOTIVE, SHOWING CHASSIS, WITH APPARATUS MOUNTED AND HOOD REMOVED.

The total weight of the train is twenty-two tons.

The freight trains are run at a slower speed, this being about twelve miles an hour. The locomotives can be made to run at a higher speed and can reach twenty-five miles an hour by changing the ratio of the speed-reduction gearing. In the former case they are able to draw a load of 100 tons, exclusive of the weight of the locomotive, while in the latter instance only one-half of this load is taken. The speed of twenty-five miles an hour is adopted when the locomotives are used to draw the passenger trains, as is sometimes the case.

Several views are shown of the three-phase locomotive which has been constructed by the Brown-Boveri company for the electric railroad. Its construction presents some interesting features. The truck of the locomotive and the spring suspension, axle boxes, etc., closely resemble the usual form of steam locomotive. The main shaft, upon which are mounted the two electric motors, one at each side of the chassis, runs in two long bearings. The latter are made exceptionally solid owing to the fact that the armatures of the motors are mounted outside of the bearings. These motors have a capacity of 150 horse-power each, making a total of 300 horse-power for the locomotive.

The transmission from motor to wheels is effected by a set of gearing and thence by a double crank-rod system, which will be noticed in the exterior view. The main motor shaft carries two pinions, which are mounted loose upon it. These pinions can be coupled to the main shaft by a suitable clutch device, and they work with a corresponding pair of gears mounted on a countershaft. Thus the countershaft is run at a speed which corresponds to twenty-five miles an hour for the train, or by the second set of gears at half this speed. From the countershaft, which lies just under the motors, two crank rods pass to the driving wheels of the locomotive on either side.

The outer field of the motor is bolted against the side of the chassis and also to the support of the main bearing. It can be removed from the chassis without disturbing any of the other parts. This is also true for the armature, which can be drawn off the shaft from the side, after removing the circular end plate or cover of the motor. In the engraving shown the cover has been taken off to show the appearance of the armature.

Westinghouse air brakes are used upon the locomotives, and the compressor is operated by a small three-phase motor. Each end of the locomotive contains a controller and different apparatus for operating, so that it can be run in either direction. A suitable housing of sheet iron is placed upon the chassis, and on the roof are mounted the four contacts of the trolley wires, two for each wire. The motors have a capacity of 150 horse-power each and operate at a normal speed of 300 revolutions per minute, using 750 volts. The two driving axles are 3.14 metres apart, and the length of the chassis between buffers is 7.8 metres. The driving wheels are 1.23 metres in diameter. Each motor weighs 4.4 tons, and the weight of the locomotive complete is thirty-two tons.

A special type of current contact has been adopted by the Brown-Boveri firm for use upon the trolley wire. As will be observed, it is of rectangular form, and two contact frames are mounted side by side upon the roof of the locomotive. There is a similar pair at each end of the locomotive, the contacts having been made double in order to secure the necessary current density and also for use in passing over switches in the overhead line. Each of the four contacts carries a maximum current density of 150 amperes per square centimetre. One point to be remarked is that the horizontal contact bar which runs under the trolley wire is pivoted at each end upon the frame and is of a triangular section, so that it always presents a flat surface to the wire. This method is used in order to keep a good contact at the high speed of running, and it is found quite successful. The trolley frame is formed of light steel tubes and is braced by steel wires stretched from the corners. In order to lower the trolley frame, which the spring tends to keep in the upright position, a cord is attached to it which the motorman uses to this effect.

The motor cars are mounted upon two bogies, each of which is equipped with two motors of the three-phase, sixty-horse-power type. Four resistances are used with the controllers, operated by a chain transmission which runs along the side of the chassis. The motors are supported upon the chassis by a spring suspension and operate the axles by a single-reduction gearing.

To start up the car the motorman makes a quarter turn of the controller lever and thus puts the circuits of the four-motor apparatus in parallel. Then continuing to turn the lever he lowers the starting resistances simultaneously for the four motors and finally reaches the short-circuit. At the same time the speed of the car increases up to the full running speed. By turning the lever in the opposite direction the car is slowed down to the full stop. To reverse the car the current in the armature circuit is inverted by means of a switch placed on the controller. The operating and the switch levers are interlocked so that no mistake can be made.

The total weight of the electric outfit per car is eleven tons and each of the motors weighs 1.6 tons. The car complete weighs thirty-five tons, with twenty-four tons for the car body. The motors operate at 600 revolutions per minute and have a speed reduction of three to one. The tension upon the motors is 750 volts. The car is 16.3 metres long between buffers. The distance between centres of the bogies is 9.5 metres, and between wheels 2.2 metres.

Electric lighting and heating is used for the motor cars and trailers on the 100-volt system. The current is taken from a three-phase transformer placed upon the car or on the locomotive. Flexible cables make connection between the cars, and it is to be noted that the three-phase system, which allows the use of a low tension for these circuits, has a decided advantage from the standpoint of safety, and is thus superior to the direct-current system where we are obliged to use the 500 volts of the line with the apparatus in series. The same transformer supplies the four-horse-power motors of the air compressors, and each car contains a similar outfit for the Westinghouse brakes, including the air cylinder. The start and stop of the compressor motor is carried out either automatically by an air-operated switch or by a switch in the motorman's cabin. The air brakes and hand brakes are only used in case of a complete stop of the car. For slowing down the speed on the down grade the motors themselves come into play and give a braking action as soon as the speed goes above synchronism, and this gives an automatic braking system which is peculiar to the alternating current, and in passing from level grade to down grade the motorman is not obliged to make any manœuvre of the apparatus. This has another advantage in lessening the wear of the brake shoes.

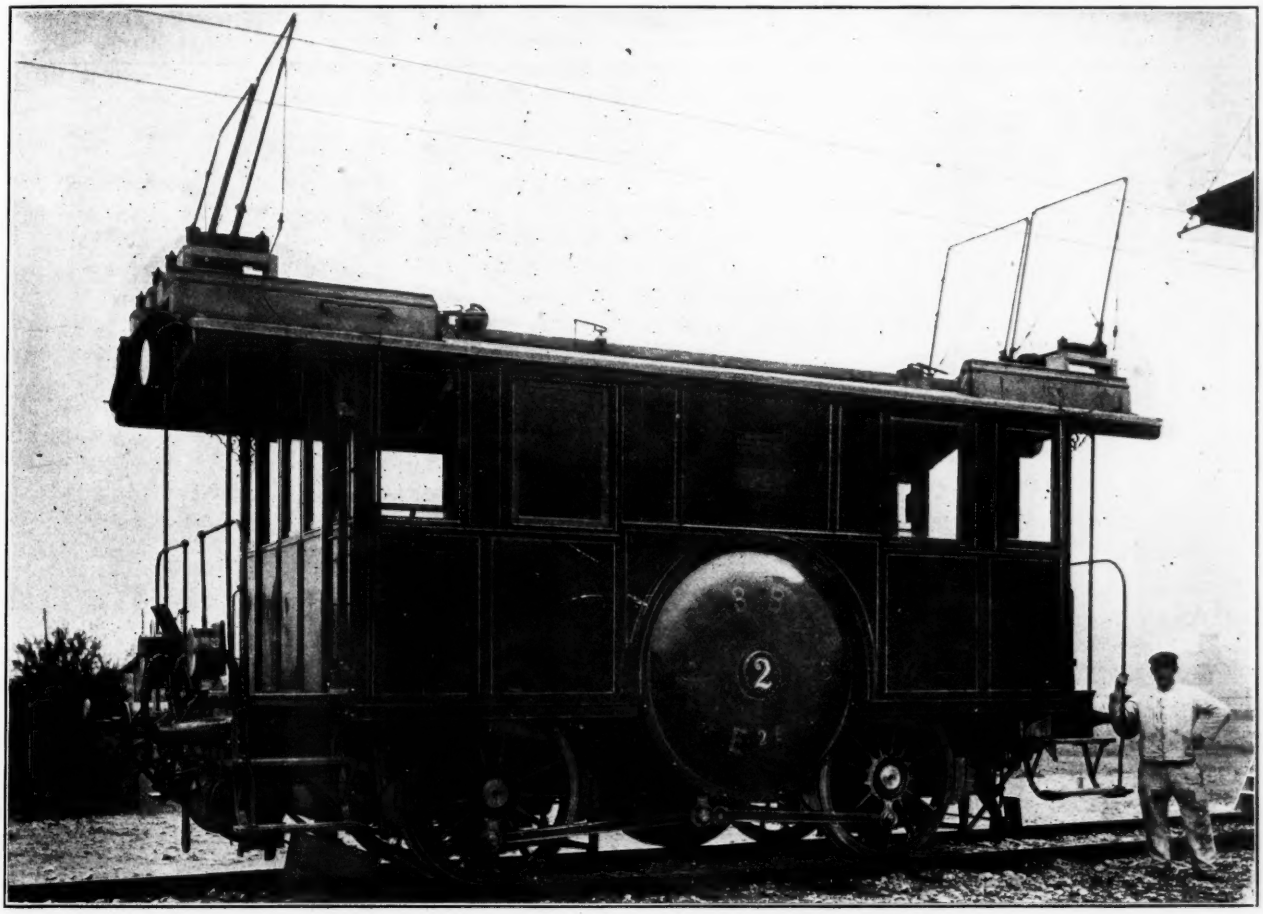
The current for the Berthoud-Thoune road is furnished from a hydraulic plant of considerable size, which is located on the river Kander, some six miles from the terminus of the road at Thoune. This station is operated by the "Motor" Company, of Baden. It uses a head of water of sixty-three metres. From the dam, which has been erected on the Kander, the water is led first in a canal and then in a sheet iron penstock to the hydraulic plant. The latter is situated on the Thoune lake

not far from the town of Spiez. The fall of the Kander gives a normal supply of seven cubic metres per second. When fully equipped the hydraulic station is to have six turbine dynamo groups. The turbines, which are rated at 900 horse-power, are built by the Swiss firm of Escher Wyss & Company. The three-phase alternators are direct-coupled to the wheels and are of the Brown-Boveri 4,000-volt pattern. Each of the alternators carries a small exciter mounted on the end of the shaft. The plant also contains two small generators driven from separate turbines. Current from these machines is sent into the fields of the exciters.

The 4,000-volt current is sent into a bank of step-up transformers, which raise it to 16,000 volts for the overhead lines which supply the electric railroad. Part of the current is also used in the cities of Berne and Berthoud. The railroad line uses a separate high-tension system of three wires, which is operated at variable load. The other circuits are designed to work at constant load for lighting and motors in the above-mentioned localities.

As regards the high-tension line and the system of transformer posts for the electric road, the 16,000-volt line has a total length of thirty miles from the turbine station to the northern terminus of the road at Berthoud. It follows along the electric road at a short distance from the latter. Along this line are placed a certain number of transformer posts, which lower the voltage and feed into the overhead trolley wire of the electric road. The latter is operated at 750 volts. The overhead line at high tension has an equal section of copper throughout the entire length. Along the electric road have been installed fourteen transformer posts, which have been placed about five miles apart on the average, as this was found to be the proper distance in order to keep the drop in voltage within the limits. The capacity to be given for each transformer post was determined according to the grade which was found on the corresponding section of the electric road, but as the figures were found to be nearly alike, the company adopted a uniform type of transformer, which is used in all the posts.

The transformer post consists of a sheet iron kiosk some twelve feet in height and is divided into an upper and a lower compartment. The lower part holds the transformer, while the upper part contains a three-pole switch for cutting off the primary circuit, also the fuse plugs for primary and secondary. By continuing the side posts of the kiosk up to some height a framework is formed of angle iron, which is used to contain the 16,000-volt lightning arresters as well as the primary and secondary lines of the transformers. Back of the kiosk is a framework of wood poles which receives the terminals of the high-tension circuit, whence the current passes across to the upper frame of the kiosk. Transformers of 450 kilowatts are used for the most part in the posts. The primary and secondary windings are coupled upon the three-phase star system. A word may be said about the construction of the Brown-Boveri transformers which are used here. They are of the oil pattern and are placed in a cast-iron box provided with cooling wings. Three cores are used for the copper coils. The two wires from

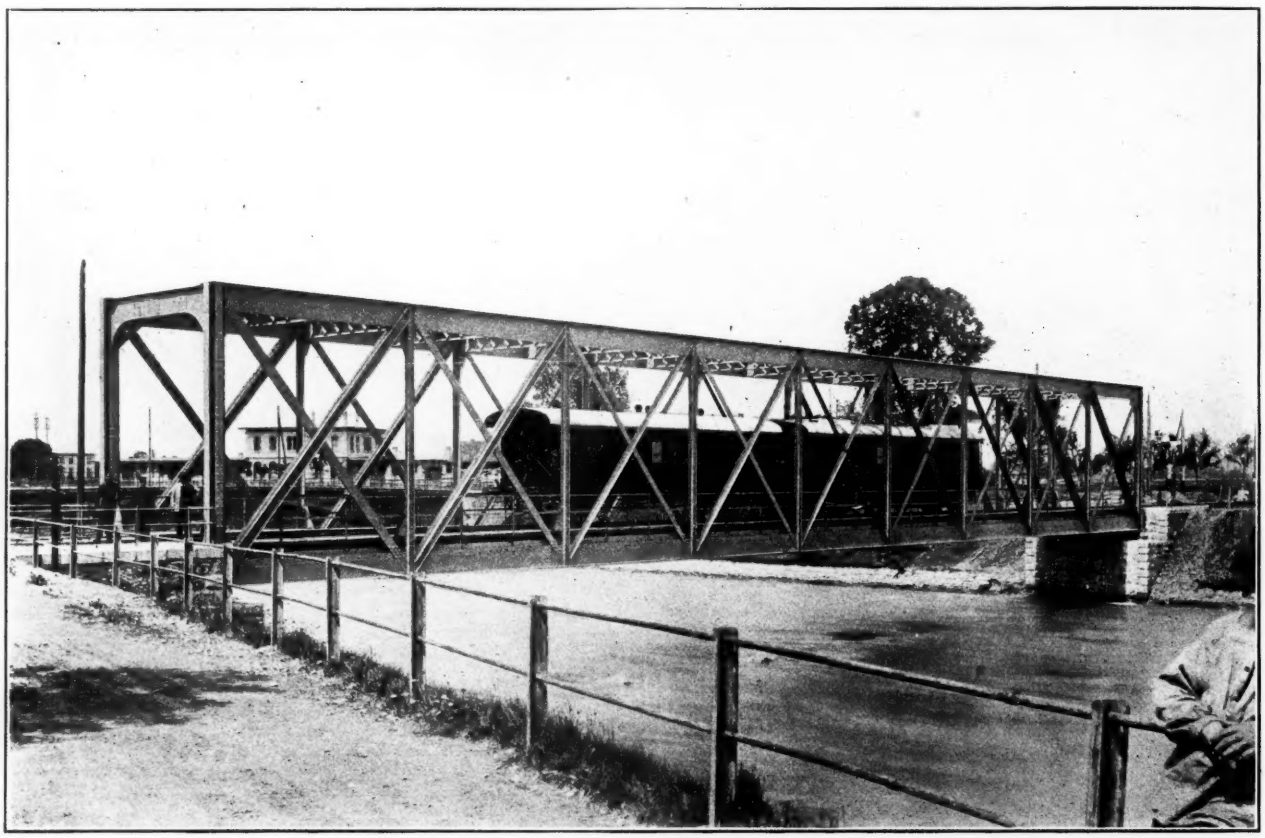


THE THREE-PHASE, ALTERNATING-CURRENT ELECTRIC LOCOMOTIVE ON THE BERTHOUD-THOUNE LINE.

the secondary, which feed the overhead trolley line, are brought from the framework above the kiosk across the two trolley lines and end at a second framework formed of two wood poles. Thence they pass below to a sheet-iron case which contains the switches and measuring instruments, also a three-phase wattmeter for measuring the energy consumed in each section and a lightning arrester. The trolley line is divided, in fact, into a certain number of sections and these correspond to the position of the transformer posts. This has been found convenient in order to localize faults in the line and make repairs. The third wire of the transformer secondary is connected with the rails of the track.

The double trolley line is formed of two hard-drawn copper wires of eight millimetres gauge. They are hung from insulators to a steel cross-wire in the usual way. Wood posts are placed on each side of the track to hold the cross-wire, or in some localities iron poles are used for the purpose. The cross-wires are placed at intervals of thirty-five metres along the track. At the suspension points the trolley wire lies 5.20 metres above the rail of the track, and the lowest point is 4.85 metres above the rail.

A new method has been employed by the Brown-Boveri company for securing a good electric contact between the rails. In this case the fish-plate is made to serve the purpose and a copper rail bond is not used. To make the contact the fish-plate and the end of the rail are well cleaned and are coated with a special metallic paste, which is a good conductor and prevents rusting. The plates are then bolted down to the rail as usual. This system has been found to work well, and the joint does not rust even after having been in use for a long period. The two rails of the track are joined across every 100 metres by an eight-millimetre copper wire. In the present system the rails are used for the return exclusively.



The Motor Car and Trailer, Berthoud-Thoune Three-Phase Alternating-Current Electric Line.

A Portable Ozone Sterilizer.

A sterilizer which purifies water by means of ozone has been developed by the Siemens & Halske Company, of Berlin. Two types are manufactured—one a stationary type with a capacity of from 200 to 600 gallons of water per hour. The ozone is generated by high-tension discharges and is then passed through a tower filled with blocks of porcelain or flints. The water drips down through this tower and is thus purified.

The portable apparatus, which is intended for military use, is mounted on two carts, one containing the ozonizer and the electrical apparatus for supplying it with current and the other the tower. The alternator is driven by a small gasoline engine of the automobile type. The same engine drives a small centrifugal pump for circulating the water through the sterilizer. There is also a fan for driving the air through the drying chamber and then though the ozonizer. Two ozonizers are supplied with each equipment, one for reserve. The step-up transformer is carried under the cart. The tower is of sheet iron, six and one-half feet high, with a cross-section of about two square feet. It is fitted with gravel the size of a pigeon's egg, and is divided into two parts with perforated bottoms. These two parts can be separated and carried in a horizontal position. Each cart weighs, when loaded, about one ton. This includes all necessary apparatus, tools and supplies. The equipment is capable of sterilizing about 200 gallons of water per hour. It requires for this about two horse-power. The apparatus is said to produce about thirty grammes of ozone per hour, although the best results are obtained with an output of fifteen grammes per hour. It is said that two outfits of this kind were used by the Russians during the recent war. One was sent to Vladivostock and the other to Harbin, where it worked from eight to ten hours a day.

Report of the Hydroelectric Power Commission of the Province of Ontario, Canada.

In the latter part of January, 1906, the lieutenant-governor of Ontario appointed a commission to investigate the hydroelectric power possibilities of the province. This commission was instructed to take up the uncompleted work of a previous similar commission. It has adopted the work of the former commission and has just rendered its first report.

The commission was instructed to report upon the present probable demand for hydraulic and electric power in the various districts capable of being supplied from the different water powers within the jurisdiction of the province of Ontario; to report upon the location, capacity and capital stock for developing the various water powers; to ascertain the rates that would be required to be charged; to enquire into the annual savings accruing through the development of the hydroelectric powers, and to determine the capital cost of present undertakings, their possible output and state of development.

The present report of the commission covers only what is designated as the Niagara district. It is accompanied by a full appendix, this being the report to the commission of the chief engineer, Cecil B. Smith. For convenience, the engineer has grouped the towns of the Niagara district, which includes the city of Toronto and that part of the province of Ontario south and west of it, geographically. Each group is to be independent of the other group, the transmission to each being distinct throughout the entire route from Niagara, except as regards right of way and telephone line. Provision, however, is to be made by interswitching stations at Hamilton and St. George for interchanging loads for night repairs between these points and Niagara Falls. As a basis for estimates of the demands for light and power, a full canvass has been made of each town and city. The total estimate of the power to be distributed in each municipality has been assumed arbitrarily at twenty-five per cent greater than the present requirements. The total amount of power to be delivered at full load is found to be 109,408 horsepower. The greatest demand comes, of course, from Toronto, which forms a division by itself, the full load here being estimated at something over 50,000 horsepower. From these estimates it is figured that, allowing for line losses, substation and transformer losses, the full load at the power station at Niagara Falls will be 120,000 horse-power.

There are a large number of rivers possessing small water powers in southwestern Ontario in the Niagara district. Certain of these have been already developed and would be available for transmission or for local use. They are, however, not considered at any length in this report. The only source of hydraulic power requiring to be considered is the water of lake Erie utilized at Niagara escarpment, which is feasible at various points, extending from and including Niagara falls westward some twenty miles. Further west than this the backbone between the escarpment and lake Erie becomes too pronounced. For power development in this locality there are in existence various charters, and under four of these extensive investments have been made and still greater investments are contemplated. The developments now partially completed are capable of meeting any demand for electric power likely to arise in Ontario in the near future, as there is about 150,000 horse-power in sight, with permanent works designed for 425,000 horse-power continuous output.

A résumé is given of the four large power companies now in operation or constructing works. These are the Hamilton Cataract Power Company, which will have, in the near future, an output of 29,000 horse-power; the Canadian Niagara Power Company, with an ultimate output of 100,000 horse-power and an output in the near future of 50,000; the Ontario Power Company, with a probable output in the near future of 60,000 horse-power and an ultimate output of .180,000, and the Toronto & Niagara Power Company, with an installation for 50,000 horse-power now going in and an ultimate capacity of 125,000. This company has nearly completed the transmission lines for delivering 30,000 horse-power in Toronto.

In view of these conditions it is considered that the better course would be for a transmission company to purchase its power at the falls and distribute this throughout the district. Should it, however, be considered advisable to construct a generating plant, a site is available immediately above the intake of the Ontario Power Company. Such a plant would have a tunnel tail-race about 5,000 feet long, with an outlet under the Horseshoe fall. This site is considered the cheapest and most suitable now available on the Canadian side of the river. It is not necessary, however, that the power plant be located in Niagara Falls, as a plant located about eighteen miles west of the falls would be more favorable in some ways. The water could there be used under a 300-foot head, and the plant would be eighteen miles nearer to the Canadian market. Preliminary estimates have shown that such a plant would cost no more per horse-power to erect than the plants at the falls, and it would take only half as much water for equal outputs.

It is estimated that a plant at Niagara Falls with an output of 100,000 horsepower for twenty-four hours would cost $86 per horse-power. With an output of 75,000 horse-power the cost would be $94, and with an output of 50,000, $116. These costs would include all the hydraulic works, the electrical equipment, transforming station and equipment, office building, engineering contingencies; in fact, all costs. It is estimated that after allowing two and one-half per cent for loss of power in transformers that the yearly cost of one horse-power-day would be $8.32, $9.05 and $11.16 for the 100,000-horse-power, 75,000-horse-power and 50,000-horse-power plants, respectively.

To determine the cost of transmission from the power-house, steel tower construction is adopted and private right of way is allowed for over the entire district. As a basis it is assumed that the cost of one horse-power-year at the generating station high-tension bus-bars will be $12. Twenty-one tables are given in the report, which show the results of the investigation. The transmission tables are divided into three classes—detail sheets, transformation detail sheets and summation sheets. The cost of power delivered naturally decreases with the amount of power disposed of. The chief cause of this variation lies in the fact that it is not feasible to put up copper for the amount of business in sight only on the expectation of adding to it from time to time. Practically speaking, the whole investment for copper, looking ahead at least five years beyond the time of commencement of sales, must be provided for at once. The estimates consider each group separately, and it is pointed out that the omission of any of the towns of any group will increase the cost of the power to the other towns. On the other hand, an unexpected demand will decrease the cost of power to the group where it arises.

The figures vary somewhat according to the demand for power in the groups and the distance from the generating station. At Hamilton, where the full-load demand is estimated at 16,000 horse-power, the cost of low tension at the substations is found to be $15.36 per year for full load and $16.29 for half load. At Toronto the full load is taken at 50,250 horsepower, and the cost per horse-power-year

at full load is found to be $16.53; at half load, $17.15. In certain of the towns lying further away from the power station and where the demand is smaller, the cost is correspondingly greater. At Dresden, for example, the cost per horse-power-year at full load is estimated at $30.87; at half load, $40.79. The full load at Dresden is only 196 kilowatts, while the transmission line would be about 190 miles long.

The figures quoted above are for the cost of power at the various municipal substations. The cost of distributing it must be considered separately for each town and city. Owing to the great amount of detail which would have been necessary for the complete working out of each place, it has been considered sufficient for the present report to take certain typical cases only. At St. Thomas, for example, the specific distribution necessary for present customers, with an allowance of twenty-five per cent for future growth, and providing for service transformers, where considered necessary in order to deliver power suitable for use in all cases (this includes electric light, street railway stations, etc.) entails a capital investment of $55,000. The annual charges, including operation, repairs, replacement fund and interest, are taken at four and one-half per cent. This also provides payment for power lost on lines and in transformers. The full load is 2,000 horse-power, which would cost, at Niagara Falls, $13.54; at the substation, $21.89, and at the consumer, $26.03.

For Toronto the capital investment for local distribution would be $2,463,000. The rates which must be charged for power vary according to the service and the amount required, being for sixty-cycle lighting and power service five cents per kilowatt-hour for light and 1.5 cents for power; for direct current, six cents for light and 1.5 cents for power; for twenty-five-cycle underground power, 1.3 cents per kilowatt-hour; overhead power, one cent; flat rates for pumping and railway service for twenty-four-hour loads, $20 per horse-power-year; for arc lamps, $47.25 per year each.

A table is given showing the costs of distribution from municipal substations for various amounts of power delivered various distances from the station. These vary from $5.58 for fifty horse-power, delivered two miles, to $22.74 for the same amount of power delivered fifteen miles; and from $2.51 for 300 horse-power, delivered two miles, to $8.32 for the same amount of power delivered fifteen miles. The latter figure is estimated on transmission at 16,500 volts.

A table is also given showing the cost to the various consumers of their electrical apparatus and the annual charges which should be made for this. By adding these items to the charges for power the total cost for any service is found.

The above estimates, while allowing for depreciation, interest and repair, make no allowance for sinking fund. It is assumed that this plant would be obsolete in forty years, and in order to provide a sinking fund which will wipe out the investment in that time a charge of sixty-eight cents per horse-power-year should be made to each consumer.

A table is given showing the rates for electric power which at present prevail in the various towns of this district, and another shows the cost of producer-gas power, which, in all cases, is found to be considerably greater than that of Niagara power.

Estimates have also been made showing what the savings would be to the cities and the electric companies if the work should be undertaken. For example, it is found that the saving to Toronto for pumping would be $53,000 a year; to the City Railway Company $217,200; to the Toronto Electric Light Company $144,800, and for other power uses $100,000, a total of $515,000.

Canadian Electrical Notes.

The Canadian Westinghouse Company, Limited, has been awarded a contract by the Montreal Street Railway Company for a large amount of apparatus. This was necessitated by the rapidly growing traffic of the company. The order included twenty quadruple equipments of 101-B railway motors complete with controllers and details; also a 1,000-kilowatt, 600-volt, direct-current, engine-type generator for installation in its main power-house, and three 500-kilowatt, three-bearing, motor-generator sets, consisting of type C motors and 550-volt, direct-current generators. These latter are similar in capacity to those now installed in their various substations, which feed directly into the trolley circuits.

The Canadian Westinghouse Company, Limited, is furnishing the T. Eaton Company, Limited, of Toronto, a 300-kilowatt, direct-current, 550-volt, engine-type generator, to be used as part of its present large power plant, which is equipped throughout with Westinghouse apparatus, and is considered one of the most up-to-date direct-current plants in Canada.

Smelting Iron Ore by Electricity.[1]

Regarding the distribution of the raw material for the production of pig iron, the conditions of Canada are such that the necessary coking coal for blast furnace work is found only at the extreme east and west, while the large stretch of country intervening occupied by the Provinces of Quebec, Ontario, Manitoba, Saskatchewan and Alberta, is without coal deposits capable of furnishing metallurgical coke, although extensive iron ore deposits occur in some of these Provinces, notably in Ontario and Quebec. If these deposits are to be utilized in the production of pig by the present methods of smelting, either coke must be brought to blast furnaces erected in the vicinity of these deposits or the ore of these Provinces must be transported to blast furnaces erected near an abundant coal supply. In either case the transportation costs render such a course uneconomic.

It was with a view of ascertaining the practicability of introducing electric smelting into Canada that the Hon. Mr. Sifton, then Minister of the Interior, appointed a commission to investigate this subject, results of which have been laid down in a special report.

The only experiments which the commission was able to witness in the electric smelting of iron ores were those made by Dr. Heroult at La Praz, France, and Mr. Keller, of Keller, Leleux & Company, at Livet. The first was a mere trial, the latter more extensive experiments continued for a number of days, but were made in furnaces not designed for the production of pig iron, but in furnaces which had been constructed for the production of ferro-silicon. The ore used in the Livet experiments had been imported for that purpose from Spain, and was an excellent hematite, very porous, free from sulphur, and containing a considerable percentage of manganese, consequently an ore easily treated in regard to sulphur, and also easily reduced.

The output of pig iron per 1,000 electric horse-power days was for one set of experiments equal to 5.76 tons, for the second set of experiments it was equal to 12.12 tons, but the iron made in this last experiment was mainly white iron. Mr. Harbord, the metallurgist of the commission, adopted as the probable output 1,000 electric horse-power days the mean of the two experiments, namely, 7.82 tons.

Not alone was this discrepancy between the two experiments very unsatisfactory

[1] Abstract of an address to the Canadian Club of Toronto, by Eugene Haanel, Ph. D., Superintendent of Mines, Ottawa.

regarding the absorption of electric energy required per ton of pig produced, but a number of points requiring determination for our Canadian ores, such as the successful smelting of magnetite, the utilization of iron ore of high sulphur content and the substitution of charcoal for coke required to be demonstrated.

As a matter of fact an experiment was made at Livet with the substitution of charcoal for coke, which proved an absolute failure, and it was assumed by Mr. Harbord and Mr. Keller that charcoal could be used only if it was first briquetted with the ore, and the briquette broken up the size of one inch cubes.

Regarding the electric smelting of iron ores of high sulphur content, Mr. Harbord states that the experiments can not be said to have demonstrated that low sulphur pig iron can be obtained without manganese in the ore mixture, and before this can be considered experimentally proved, it will be necessary to have a series of experiments made with non-manganiferous ores.

For the successful introduction of electric smelting of Canadian ores the following points which could not be settled by the European experiments, required demonstration:

Can magnetite, which is our chief ore, and which to some extent is a conductor of electricity, be successfully smelted?

Can iron ores with considerable sulphur content be made into pig iron of marketable composition?

Can charcoal, which can be made from mill refuse and other available sources of wood useless for other purposes, be substituted for coke, which must be imported?

And lastly, what is the exact amount of electric energy required per ton of pig iron produced?

With a view of ascertaining these important facts experimentally, I prepared a memorandum to the Hon. Mr. Oliver, Minister of the Interior, recommending an appropriation for the investigation of the whole subject.

It was fortunate that Dr. Heroult, of La Praz, who had been the first to experiment on the subject of electric smelting of iron ores, happened at that time to be on a visit in Ottawa. He signified his consent, if the appropriation were made, to undertake the designing of a furnace of about 250 horse-power capacity, and the investigation of the factors entering into the economic production of pig iron from Canadian iron ores by the electrothermic process.

The Lake Superior Power Company, of Sault Ste. Marie, offered a building in which to erect the plant, and the use of one of their alternators of 300 electric horse-power capacity, free of expense for four months. It was decided to accept this offer, and the plant was ordered to be erected in the building provided for this purpose.

The necessary transformer to transform the current down from 2,200 volts to about 400, such as was required for our experiments, and the necessary measuring instruments to determine the power consumed were ordered, and electrodes six feet long and sixteen inches square section were ordered from Sweden. The construction of bins, overhead work of the furnace, construction and erection of furnace and experimentation to adjust the capacity of the crucible of the furnace to the power available consumed the greater part of the fall and winter.

The experimentation on Canadian ores began in earnest about the middle of February, the furnace being in operation night and day, with some few intermissions, until the fifth of March. During that time about 150 casts were made, yielding about fifty-five tons of pig iron. For the first experiments the ores employed were hematite, such as used by the Algoma Steel Company, in their blast furnaces; for the remainder of the experiments different classes of Canadian magnetite from different sources, all of high sulphur content, with the exception of the Wilbur magnetite, which was low in sulphur, were employed.

EXCEEDS ANTICIPATION.

The very first experiment with magnetite proved that our fears had been groundless, and that magnetite could be smelted with as much facility as hematite, and with an output equal to that of the best experiment made with hematite. Moreover, since it was important to substitute, if possible, charcoal, which can be cheaply produced in Canada, for coke, which is dear and which must be imported, the charges were made with charcoal. No difficulty was experienced whatsoever, the furnace working quietly and regularly, requiring little attention to the regulation of the electrode.

Analysis of the iron produced soon proved that although the slag was not particularly basic, the sulphur could be caused to pass into the slag, resulting in a pig iron containing a few thousandths of a per cent of sulphur. In every instance the output was far greater—in several instances one-third greater than the figure adopted by Mr. Harbord in the report of the commission on electric smelting.

Upon the attainment of these remarkable results and the desulphurization due to the higher temperature available in the electric furnace over that of the blast furnace it was decided to experiment with the roasted and briquetted nickeliferous pyrrhotite, of which there were several thousand tons in stock in the yards. An analysis of these briquettes showed that they contained about 1.6 per cent of sulphur. The experiments were entirely successful, furnishing a ferro-nickel pig containing 4½ per cent of nickel, and virtually free from sulphur, that is, containing only about six-thousandths of a per cent. The estimated value of this product is from $40 to $44 per ton. So successful have these experiments proven that the Lake Superior Power Corporation have decided to acquire the government plant for the purpose of converting their stock of briquetted ore into marketable ferro-nickel pig.

One of the most important points in the investigation, which could not be successfully settled by the experiments at Livet, was the consumption of the electrodes, and it was found that the consumption was beyond expectation small, and that an electrode which had been in use for three weeks, and during that time had been exposed to free air in an incandescent state for many hours, and had been used for melting down charges, which is always attended by waste of electrode without corresponding output in metal, that even with this severe test the consumption per ton of pig iron produced was between fifteen and twenty pounds. Dr. Heroult states that by his process of manufacturing electrodes one pound would cost about one and one-half cents, so that thirty cents would be a maximum outlay per ton of pig for electrode consumed, instead of seventy-seven cents as given in the commission's report.

WHAT THE RESULTS MEAN.

The far-reaching consequences of the gratifying results achieved by these experiments will at once be apparent. Many of our magnetites are too high in sulphur to be handled by the blast furnace, and consequently have so far been of no commercial value. But the very best of pig iron, as has been proven, can be made from ores which contain as high as one per cent of sulphur. A blast furnace will not usually handle an ore which contains more than one-tenth per cent of sulphur and requires, therefore, an ore which

can not be got at a low figure. The Algoma Steel Works pay, I understand, $4.50 for the hematite which they use in their blast furnaces. A pig iron equal in value and lower in sulphur content, can be made by the electric process from sulphurous ores, which could be bought for $1.25.

Regarding the water-power required for the application of this process, it may be stated that many water-powers exist in Ontario surrounded by iron ore fields in localities ill-adapted for the application of electric energy for any other purpose, and could be developed to furnish an electric horse-power year from $4.50 to $6.

With such a price for the energy required the small consumption of electrode, the cheapness of the ore employed, and the peculiar excellence of the pig iron produced, electric smelting of iron ores in Canada, using charcoal or peat coke made from our peat bogs of enormous extent, may be pronounced a commercial success. Under the prevailing conditions in Canada, it now only remains for the engineer to design a plant on a commercial scale, say of 100 to 150 tons daily output, with all the necessary labor-saving appliances. Just as in the case of the blast furnace so likewise with the electric furnace, experience gained will result in further economy, and the day may not be far distant when the carbon monoxide, which is of high calorific value, and which at present as a product of the reaction taking place in the electric furnace is allowed to escape without utilization, will be employed for increasing the output by at least one-third if not one-half. If that should take place, the blast furnace could not compete with the electric furnace, even under conditions where coke might be cheaper than at present quoted in Ontario and Quebec.

A further advantage of the electric process should be pointed out, in that the units employed are comparatively small and cheap of construction. A unit of 1,500 horse-power is perhaps the largest that under present circumstances should be constructed. Such a unit would have an output of about eighteen tons per day, and corresponds in size to about the larger Swedish charcoal blast furnaces. With the present advance which has been made in the transference of electric energy batteries of electric furnaces could set up at various iron ore deposits, which could be fed with electric energy from some centrally located water-power, thus effecting a saving of the transportation costs of the ore from the mine to the furnace. When a deposit is worked out the furnace may be moved to the next deposit, simply lengthening the wires which carry the high-tension current to the transformers of the plant. This method is especially applicable in the case of the many pocketty deposits of magnetite which occur in the Ottawa Valley.

The following is a summary of the results of the experiments which have been made under government auspices at Sault Ste. Marie:

First.—Canadian ores chiefly magnetite can be economically smelted by the electrothermic process.

Second.—Ores of high sulphur content can be made into pig iron containing only a few thousands of a per cent of sulphur.

Third.—The silicon content can be varied as required for the class of pig to be produced.

Fourth.—Charcoal which can be cheaply produced from mill refuse or wood which could not otherwise be utilized and peat coke made from peat, of which there are abundant deposits in Ontario and Quebec, can be substituted for coke without being briquetted with the ore.

Fifth.—A ferro-nickel pig can be produced practically free from sulphur, and of fine quality from roasted nickeliferous pyrrhotite.

Sixth.—Pyrite cinders, resulting from the roasting of pyrite in the manufacture of sulphuric acid and which at present constitute a waste product, can be smelted into pig iron by the electric process.

Seventh.—Titaniferous iron ores containing up to five per cent can be successfully treated by the electrothermic process. This conclusion is based upon an experiment made with an ore containing thirty-five per cent of titanic acid, yielding a pig iron of passable quality, judging from its fracture.

The results of the introduction of electric smelting into Canada may be summarized as follows:

First.—The utilization of our extensive water-powers, which can not at present be profitably employed for any other purpose.

Second.—The utilization of the large number of iron ore deposits, which, on account of their high sulphur content can not be treated by blast furnace methods and have so far been valueless. This is of extreme importance, for already the question has arisen, how long the present supply of blast furnace iron ore is likely to last, and ores are now accepted by furnace men with a metallic content such as would not have been looked at a few years ago, and when these ores are exhausted and none but sulphurous ores or titaniferous ores are available, the stacks of the numerous blast furnaces, which have rendered such magnificent service to our present civilization, will be silent and smokeless, having been supplanted by the electric furnace which can successfully treat an ore which the blast furnace can not handle.

Third.—The utilization of our extensive peat bogs for the production of peat coke, to be used as reducing material for the operation of electric furnaces, and utilization of mill refuse and sawdust, for which there has so far been no practical use.

Fourth.—Rendering Canada independent of fuel import for metallurgical processes.

Fifth.—Enabling Canada to produce her own pig iron from her abundant sources for home consumption and consequently retaining in our own country the money which otherwise would have to be sent abroad to purchase pig iron in the crude and manufactured state.

Sixth.—The development of steel plants and rolling mills using only electric energy.

Electricity for Canals.

United States Vice-Consul Fuller, of Hanover, Germany, reports that the Siemens & Halske Company is testing a new method of electric traction on the Teltow canal. The original trials of electric traction on this canal made use of tractors built symmetrically so that they could run in either direction. This plan seemed satisfactory, and a new system has been worked out. The new motors operate in one direction only, and a track for them has been laid on each side of the canal.

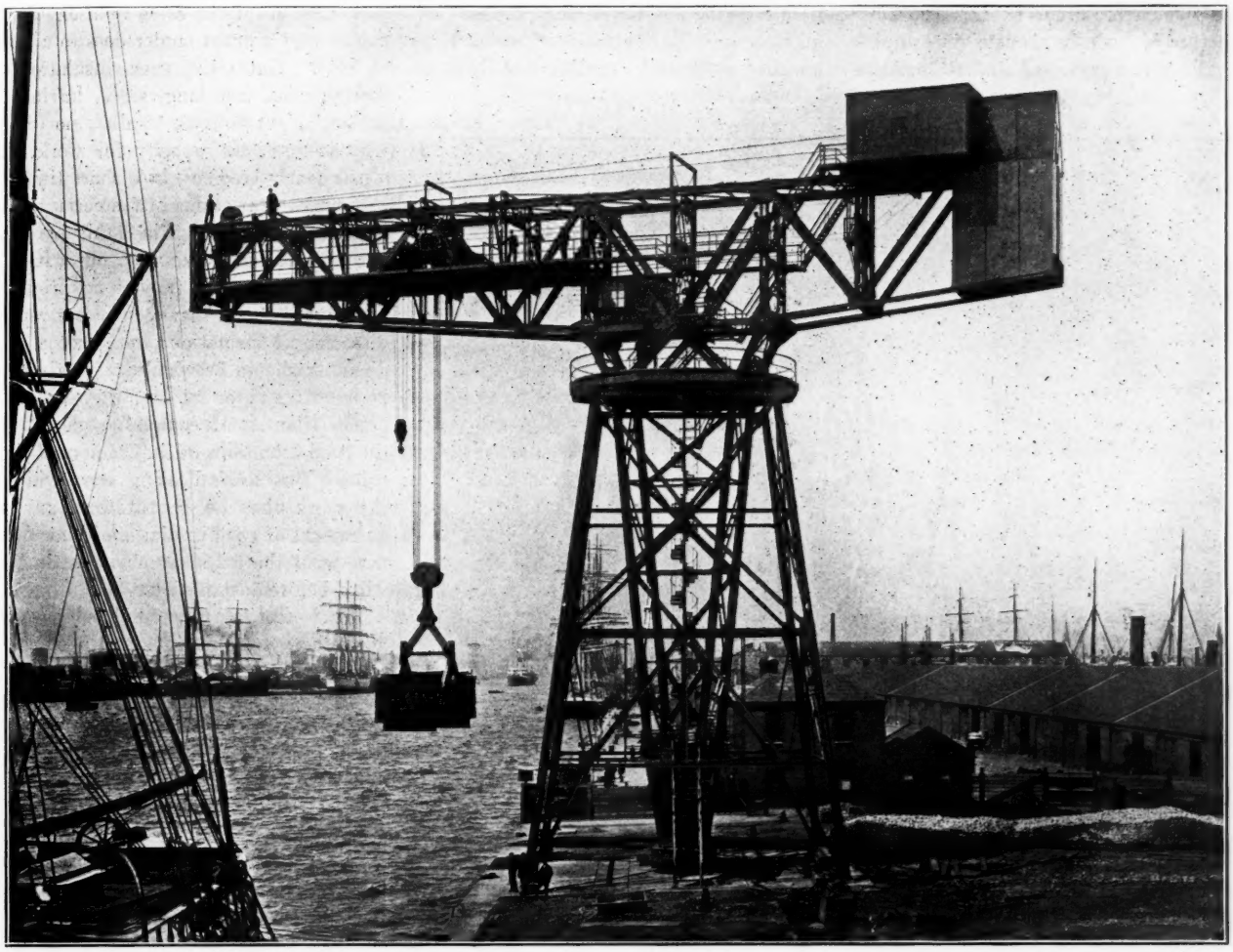
The weight of the motor is distributed so that about six-tenths of it rests on the land side of the track. The motor runs on three axles, the front two being mounted on a swiveling truck. Both axles of this truck are driven through gears by two ten-horse-power, direct-current motors. Power is supplied to the motors at 550 volts, series parallel control being employed. Running unloaded the motor makes a speed of a little over three miles an hour under series control and about double this running with the two motors in parallel.

The towing line is controlled by a one-horse-power motor, which drives the drum upon which the line is wound. There is also a motor for controlling the towing pole through which the line is carried.

Electric High-Power Tower Cranes in German and Irish Harbors.

By Frank C. Perkins.

TWO of the most important tower cranes in European harbors are in operation by the Dublin Port and Docks Board, and at the Kaiser Wilhelm Hafen, in Hamburg. The former has a capacity of 100 tons under normal conditions, and is capable of carrying loads as high as 150 tons as a maximum. This crane as well as the tower crane of seventy-five tons capacity at the Hamburg harbor are shown in the accompanying illustrations, the one dumping a car of coal into a barge and the other handling many tons of steel rails in a single lift. The German seventy-five-ton crane has a maximum capacity of 100 tons and will raise this load at a speed of 1.4 metres per minute, while the speed may be increased to ten metres per minute, with a load of 7.5 tons. This tower crane will make a complete revolution in about five minutes, and the empty hook may be lowered at the speed of from six to eight metres per minute. The radius of action of the crane is 30.4 metres, with a load of 7.5 tons, this being somewhat reduced to 28.9 metres for a load of forty-five tons and still further reduced to twenty-three metres with a load of seventy-five tons, or when carrying a maximum weight of 100 tons. The hoisting distance possible with this crane is thirty-six metres, and the traveling trolley on the top of the crane travels at a speed of from eight to nine metres per minute when carrying a load of seventy-five tons.



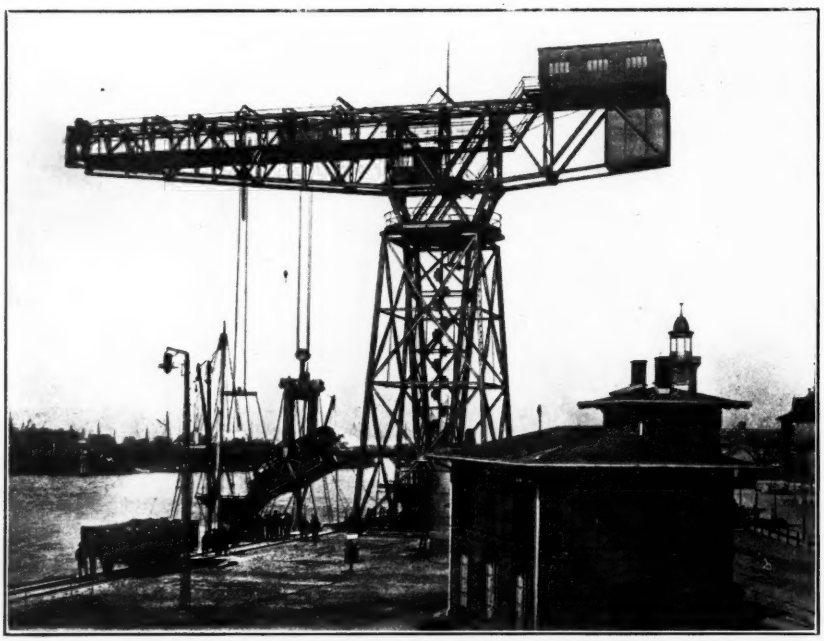
ELECTRICALLY OPERATED 100-TON TOWER CRANE AT DUBLIN HARBOR.

The Hamburg crane is operated by electric motors, five in number, from a power circuit supplying current at a pressure of 450 volts. There are two hoisting motors, each having a capacity of 22.5 horsepower and operating at a speed of 290 revolutions per minute when connected in series, this speed being increased to 580 revolutions per minute when the motors are connected in parallel.

There is also another hoisting motor of thirty horse-power capacity operating at a speed of 730 revolutions per minute, while a twenty-four-horse-power motor is provided for moving the trolley from the top of the tower, the speed of this machine being 850 revolutions per minute. The turning motor is of somewhat smaller capacity, operating at a speed of 1,250 revolutions per minute and developing under normal conditions about nineteen horse-power. This crane, shown in the accompanying illustration, as well as the 100-ton tower crane installed at the Dublin harbor, were built at Nurnberg, Germany, by the Vereinigsten Maschenin Fabrik Augsburg und Maschinenbau Gesellschaft, Nurnberg.

The latter crane is lighted by incandescent lamps, the current being supplied

for this purpose as well as for operating the electrical motors from a direct-current circuit of 500 volts pressure. This Irish crane is capable of carrying a load of 20,000 kilogrammes, with a maximum radius of eighty feet and 150,000 kilogrammes at seventy-five feet. It will raise loads of 100 tons to a height of 100 feet and at a speed of five feet per minute. The hoisting speed is increased to ten feet per minute with a load of 50,000 kilogrammes, and to twenty feet per minute with a load of 20,000 kilogrammes. The trolley moves along the crane at a speed of twenty-eight feet per minute, while a complete revolution of this enormous structure is made in about eight minutes. There are five cranes of similar construc-



Electrically Driven, Seventy-five-Ton Tower Crane at Hamburg, Germany.

tion at the Emden and Hamburg harbor, one of which is shown in operation at the latter harbor in the accompanying illustration. The electrical equipment of the Dublin crane was installed by Siemens Brothers & Company, Limited, of London. Automatic brakes are provided on this crane, which are controlled by electromagnets and make the operation of the crane safe and reliable. The large boilers as well as the heavy parts of the electrical generators and high power reciprocating engines of the Dublin municipal electric lighting plant were all handled by this crane, being transferred from the ships to the docks by means of this labor-saving device during the recent construction of this important Irish electric station.

STANDARDIZING RUBBER-COVERED WIRES AND CABLES.[1]

BY JOHN LANGAN.

The effect of the tendency toward high electrical pressures is nowhere more severely felt than in the requirement for insulated wires and cables, for insulation practically controls this feature of electrical distribution. Electrical pressures can, to be sure, be increased to almost any extent, and electrical energy be transmitted to almost any distance; but to control its pathway, to regulate its course, to prevent waste, and maintain safety, this is the problem—the big underlying problem—of all electrical distributions of to-day. Five hundred volts and under are easily controlled; but pressures of 5,000, 10,000 or 20,000 volts introduce new problems, problems that were not even thought of in the days when 110 volts was considered standard practice.

On the distributing and not the generating medium, then, depends the success of the present tendency in electrical distribution. A badly insulated wire or cable will imperil the success of any system. Not only must the insulation itself be perfect, it must also be properly tested, properly installed and properly protected. And curiously enough, engineers while examining carefully every other feature of a transmission system, will often pass lightly over the question of cables. Cables, some appear to think, are all alike. If they possess the common identity of copper, this establishes a relationship of equality, and laboring under this very general illusion, rubber-covered cables are called for and purchased with no other restriction as to quality than that they shall conform to the National Code or the Board of Fire Underwriters' rules. All this wire made subject to "code" rules passes under the general but misleading name of "rubber covered," when, as a matter of fact, there is not an ounce of rubber in its composition. It is composed of cheap ingredients, rubber substitutes and the like, and bears about the same relation to fine rubber that a burnt cinder does to a lump of coal. Naturally, such insulation as this will not last long, since, having no rubber, it possesses no vitality, no dielectric strength, no capacity for work, and consequently becomes, in a short time, an easy prey to variations of temperature and climatic conditions. The fault here lies not with the manufacturer, but with the rules; for the rules impose no provision as to quality. All they require is a certain diameter of insulation; but whether this diameter should be wholly or partly composed of mud or rubber, they are altogether silent. Of course, no one doubts the good intentions of the framers of these rules. But as indicating how wide of the mark they go in fulfilling any requirement of good insulation, let me quote here what the rules say about testing the wires before installation.

"Each foot of the completed covering must show a dielectric strength sufficient to resist for five (5) minutes the application of 3,000 volts per 1/64 of an inch thickness of insulation."

For example, they would require a conductor with 10/32-inch wall of insulation to stand a test of 60,000 volts; or a No. 14 wire which calls for 3/64-inch wall, a test of 9,000 volts. The absurdity of these tests must be evident to any one having the slightest familiarity with the practical side of electrical engineering. From what source such data were derived is hard to tell; for there is not the slightest warrant either in theory or in practice for it. Even the highest grade of fine Para would stand no such test, much less the cheap, bituminous rubbish that enters virtually into every foot of what is termed "code wire."

The rules say that the insulation must stand 3,000 volts for every 1/64-inch wall of insulation. This requirement is, to be sure, absurd. But supposing this possible, who is to enforce it? No one, and no one does. The situation is like a body

[1] A paper presented at the 206th meeting of the American Institute of Electrical Engineers, New York, April 27, 1906.

of law givers formulating an arbitrary law, but making absolutely no provision for any one to enforce the law. In the case of the big telephone, telegraph and power companies, in or contiguous to New York; that is, contiguous to the manufacturers, this is simple enough, as they send a qualified engineer to make the necessary tests at the manufacturer's plant. But what is the engineer or consumer to do who lives in New Orleans or San Francisco or Chicago? Clearly he can not journey to New York to test his wire, and so is forced to accept any old thing that is called "rubber-covered" when, as a matter of fact, it might be entirely destitute of any rubber.

The object then of this paper is to point out and define means of standardizing rubber insulation. There is now no standard, no guide, nothing whatever to compel a uniformity of compound, excepting such as is obtained through a tedious and expensive chemical analysis. In doing this, however, it is not proposed to touch at all on technical and mathematical questions, such as capacity, heating, static conditions, and the like. These are matters which properly concern the electrical and consulting engineer, and while of great importance, are, after all, subordinate to the more vital and practical questions of good insulation. With this assured, everything else logically follows. And besides, theoretical formulæ are of little value unless based on something specific and definite. With variable and uncertain premises, you can not avoid variable and uncertain conclusions. And it is because of this widely varying character of rubber insulation that nearly all such formulæ are uncertain and misleading. Under existing conditions then the electrical engineer has little in the way of data to guide him in obtaining reliable insulation.

This, I know, sounds very heterodox. For if there is any one dogmatism to which electrical practice seems unchangeably attached, it is that of a firm belief in the value of a voltage test in determining dielectric efficiency. Yet nothing could be more misleading. Indeed it may be affirmed that a potential test is, in itself, no criterion whatever of permanent value. As an aid—as a collateral agent—it does, however, play an important part. But as indicating, much less proving, permanent merit, nothing could be more misleading and empirical. And the reason for this will, on a little reflection, be obvious enough.

You are all familiar with the influence of certain oils on high-tension switches and transformers. These withstand potentials that, without these adventitious aids, would be altogether impossible. Certain mineral and vegetable oils will, therefore, stand extremely high pressures, and in this we have a clue, and even a proof, why many obviously cheap insulating compounds stand very high potential tests, and yet will, in a short time, break down in actual service. The logic of this anomalous condition is, that when these communicated oils in the compound evaporate—as they will in a short time—the temporary and adventitious virtues they possess disappear also, and the insulation, deprived of this artificial support, quickly falls into disintegration and decay. This is the inevitable history of all such combinations. The situation is somewhat akin to a horse "doped" for a race, who shows a surprising turn of speed for a short distance and then suddenly collapses. From this it will be seen that a puncture test is, in itself, an uncertain proof of dielectric excellence.

What is it then that constitutes good insulation, and how can we ascertain and know it? This is the all-important question. With this assured, everything else logically follows. The consensus of opinion, derived alike from theoretical and practical experience, is that rubber is the best of all insulating materials. There will, it is believed, be little dissent from this established conclusion. Its use to-day is practically universal. It has survived the vicissitudes of time and experience, has successfully refuted the claims of all alleged substitutes, and stands to-day the unrivaled and indisputable factor in transmission, without which electrical progress would be uncertain and precarious. We need not, therefore, resort to any detailed proof of rubber's right to insulating preeminence. Twenty years of practical experience justifies the wisdom of its use. In fact, it is the quantity and quality of the rubber in the compound that differentiates the grade and determines the price of every wire and cable on the market.

But while rubber is the principal feature of good insulation, it is not the only feature. As a matter of fact, rubber in itself is valueless as an insulating medium. The reason for this is that in its native condition it absorbs a certain amount of moisture, and when exposed to the air readily oxidizes. These factors of disintegration naturally preclude its use as a distinct and separate constituent for insulating purposes. But in conjunction with other ingredients, and when allied with sulphur, and properly vulcanized, it becomes not only absolutely waterproof, but indeed, under normal conditions, one might say, indestructible. From this it will be seen that there are two factors involved in good insulation. The fundamental thing is, of course, that the rubber be fine Para. But it does not matter how good the rubber is or how much of it is incorporated in the compound, if the vulcanization is not properly carried out, the insulation will be defective. In fact, it is hardly exaggerating things to say that the art, or the science, of rubber insulation resides chiefly in the proper understanding of vulcanization. This consists in the addition of a certain percentage of sulphur—generally about three per cent—to the rubber and then subjecting this association to a certain temperature for a certain duration of time. The result is vulcanized rubber. Vulcanization, then, is that more or less mysterious factor which gives the rubber longevity, durability and immunity from oxidation when exposed to atmospheric and other conditions. In short, it is what may be called "embalming" the rubber. Without it rubber is absolutely worthless for insulating purposes; with it, it becomes, under normal conditions, virtually indestructible.

Bear in mind, however, that there are many and different grades of rubber, all varying in price as in quality, and it is only by a knowledge and recognition of this wide diversity of character that an engineer can intelligently make up specifications and rigidly enforce them.

Chemically considered, rubber is differentiated by the amount of acetone soluble, extractive or resinous matter which it contains, and physically by its tensile strength. Both, of course, are closely related; for where it is chemically poor, it is also physically weak. In brief, a high percentage of resinous matter is indicative of the cheaper grades, such as African, Madagascar, and some South American products; and a low percentage indicates the best grades of fine Para, such as Bolivia, Madeira and Up-River. The best grades differ little as to merit, whereas the others fluctuate a great deal as to quality and price. In the former the resinous matter is as high as twenty per cent and in the latter it seldom exceeds one per cent.

This, then, is the chemical reason for the high regard in which fine Para is held, and it is with this grade that the following specifications and tests will be exclusively associated. You will observe from this, that in proportion as rubber is high in extractive matter, its estimation is low; and vice versa, that as it is low in extractive matter, its price is high. In

other words, both quality and price will vary inversely with the amount of resinous matter.

These commercial aspects are the result of practical experience; for it has been found that the life of rubber bears a direct relationship to the resinous matter it contains. It is, therefore, of evident importance to have an elementary knowledge of these characteristics; for it is a lack of this knowledge that is responsible for the wide and general mischief caused by the belief that all wires and cables called "rubber covered" are alike, when, in reality, if they possess any rubber at all, they may have nothing in common but the copper conductor.

With the physical aspect of rubber, you are all, no doubt, more or less familiar. It is, as you know, astonishingly strong; indeed, it is doubtful if a piece of fresh fine Para, of a few inches in diameter, could possibly be broken by the average man. It is very elastic, too, stretching to such an extent as to render a substance in itself opaque, perfectly translucent.

Now, from an analysis of these facts, it will be perfectly obvious, that, since rubber is in itself very strong and very elastic, these characteristics should be present in any insulated wire in proportion to the quantity and quality of the rubber in the insulation. And from this it would seem that good insulation resolves itself largely into a question of tensile strength. This, on the whole, is true. But owing to the immense influence exerted by vulcanization, this is subject to important modifications which will be referred to, and enlarged on, as we progress in this paper.

It is well known that while vulcanization, when properly done, does not alter the constitution of rubber, yet it can be made to affect adversely or deceptively modify its behavior. For example, if it is over-vulcanized it will become hard and somewhat brittle; and if under-vulcanized, it will become flabby and inert. In either case the result is indicative of imperfect insulation, and will not fulfill the requirements of a tensile test. In one case it will break and in the other it will stretch but not return. Good insulation, then, is clearly indicated by its prompt return after being stretched several times to, say, three to four times its length. Stretching to three and one-half times its length, as above indicated, is, roughly speaking, equal to about 800 pounds to the square inch. But bear in mind that merely stretching implies nothing; almost any kind of rubber will stretch. But where the first-class rubber is, the insulation will jump back with a vigor somewhat similar to a magnetic pull. What, however, is aimed at in this test is a tensile strain of not less than 800 pounds to the square inch, and wherever practicable this is much more effective in weeding out the cheaper grades of rubber than the elongation test alone is.

Now, it has been clearly and repeatedly proved that where there is thirty per cent of fine Para in the insulation, this physical test is easily obtained. Of this there is not the slightest doubt. In obtaining this proof every manufacturer on the American market unwittingly contributed to the result. It was felt that to rely on any one brand or any one make would be one-sided and inadequate, and so every grade or combination of grades of different manufacturers was chemically analyzed in order to verify the physical tests obtained. The object was to discover a physical test that would enable the electrical engineer to obtain by a simple, inexpensive method what can, with precision, be obtained only by a tedious and expensive chemical analysis. The original calculations were based on the assumption that since thirty per cent of Para does, unmistakably, produce the tensile tests already referred to, any insulation fulfilling these must, necessarily, possess thirty per cent also. But it was found that a combination of a lesser amount of Para and a large amount of a cheaper grade of rubber would initially, at any rate, produce the same test that thirty per cent of fine Para would. But to do it successfully the compound has to contain between forty and fifty per cent of this cheaper grade. This can best be explained by a single example: bids were asked for on a 20,000-volt cable, the insulation to contain not less than thirty per cent of fine Para, free from all shoddy, rubber substitutes and the like. The first two samples submitted did not meet the physical test and were rejected. The third experiment was successful, met all the requirements specified, electrically and physically, but on a chemical analysis, here is what it contained: fifteen per cent of Para and thirty per cent of some cheaper grade of rubber, making all told forty-five per cent to meet the requirements of the specifications. Now, this is an extremely interesting exhibit, the import of which will, it is hoped, be evident to all.

The first lesson that it conveys is that this physical test, rigidly enforced, precludes absolutely the use of shoddy, bituminous products, and even the cheap grades of rubber. The second is that it takes forty to fifty per cent of a cheaper combination to do what thirty per cent of pure Para will do.

Another way of looking at it is that the physical test does not, in itself, prove that the insulating compound contains nothing else but pure Para. This, to be sure, is a drawback to its exclusive use where the best results are wished for. But, on the other hand, if it does not give you the best, it does, at any rate, wipe out all cheap rubber substitutes and gives you an insulation that, if not equal in durability to thirty per cent of Para, is immeasurably superior to anything you can now obtain by any other means short of a chemical analysis. This, in itself, is an immense advantage. It enables the distant engineer to do what he could not do heretofore; to tell off-hand what the character of the insulation is; that is, to strip the insulation from the wire and test according to the specifications herein to follow. Any one can verify the value of it by getting some code wire and applying this test to it, or indeed, for that matter, the best wire to be found on the market and see what the comparison will reveal.

In this test we have, it is believed, a cure for the growing degeneration of National Code wire. It enables the board of underwriters, architects and engineers —all who are responsible for this class of work—to test off-hand, and without expense or trouble, the character of the insulation.

But while it does all this the fact remains that the physical test alone does not compel precise results—does not necessarily compel thirty per cent of fine Para in the insulating compound. It does, however, compel thirty per cent of rubber. This, as I have already said, is an immense advance over the bituminous products you could ordinarily get. But there is rubber and rubber as there are men and men, and I am purposely reiterating this difference again so that you will carefully distinguish between cheap grades and the fine Para.

How to obtain—how to compel—thirty per cent of fine Para in the insulating compound is, then, the problem, where the best and most enduring results are desired. There is, unfortunately, no way short of a chemical analysis of proving this. And even then we are constantly beset by stubborn facts and obscure difficulties which may neutralize the value of an analysis unless the specifications be carefully worded. For the chemist—and he must be a very skilful one at that—can prove nothing whatever except by imposing rigid restrictions as to what the

compound shall contain. For example: were you to merely say that the compound shall contain thirty per cent of rubber and leave it at that then the analysis would prove nothing more than that there was thirty per cent of rubber in it, but whether it was good, bad or middling rubber it could not be determined. Now, this is one of the perplexities of a chemical analysis of rubber insulation. There is, however, a way of arriving at chemical precision, one which proves indubitably the character of the rubber employed.

In the earlier part of the paper it was noted that the extractive or resinous matter in the rubber differentiated its grade; that is, the best grade of rubber has seldom more than one per cent and the cheaper varying from five to twenty per cent. From this it will be seen that by limiting the amount of resinous or extractive matter that should appear on a chemical analysis in the compound you thereby determine the grade of the rubber. Of this there is not the slightest doubt. You can verify this for yourself in the following way: ask for a price first on a wire or cable to contain, say, thirty per cent of rubber, and compare the cost of this with another which calls for thirty per cent of fine Para, the extractive matter in which, on a chemical analysis, shall not exceed from three to five per cent. To all who are keenly analytical the question will naturally occur, why allow three to five per cent of extractive matter in this analysis when the fine Para itself has native to it only about one to one and one-half per cent? Well, in the first place, during vulcanization, the extractive matter in a thirty per cent fine Para compound for some cause increases to about three per cent. We do not, at present, fully understand why this should be so, but it is so. And, in the next place, the addition of some extractive matter to this inherent or natural amount is considered by the manufacturers a good thing for the insulation. But the total in the completed or braided wire should never exceed five per cent; for beyond this limit the chemist can not differentiate the grade of the rubber, and thus the value of the analysis is compromised and useless. For this reason tests should be made on the completed wire rather than on an unfinished sample.

The following specifications will, it is hoped, in view of what has been said, be intelligible to all:

SPECIFICATIONS FOR RUBBER-INSULATED WIRES AND CABLES.

All conductors to have at least ninety-eight per cent conductivity and to be thoroughly and evenly tinned.

The insulating compound to contain not less than thirty per cent and not more than thirty-two per cent of fine Para rubber. No shoddy, reclaimed rubber, rubber substitutes, or the like, must, in any form, be in the compound, the extractive matter of which, when chemically analyzed, must not exceed five per cent.

All wires and cables properly insulated in accordance with the above provisions must, after forty-eight hours' immersion in water, at a temperature of sixty degrees Fahrenheit and before tape, braid or lead is applied, show the following insulation resistance and voltage tests. Insulation test to be made with a battery of 100 volts after one minute's electrification:

LOW POTENTIAL, 600 VOLTS.

B. & S. Gauge.	Wall. Inches.	Voltage Test for One Minute.	Insulation Resistance. Megohms per Mile.
No. 14 to 8.	3/64	1,000	1,000
6 to 2.	4/64	1,000	1,000
1 to 4/0.....	5/64	1,000	1,000
250,000 to 500,000 C.-M.	6/64	1,000	750
550,000 to 1,000,000 C.-M.	7/64	1,000	500

MEDIUM POTENTIAL, 3,500 VOLTS.

B. & S. Gauge.	Wall. Inches.	Voltage Test for One Minute.	Insulation Resistance. Megohms per Mile.
No. 14 to 8..	3/32	5,000	3,000
6 to 2..	3/32	5,000	2,500
1 to 4/0.....	3/32	5,000	2,000
250,000 to 500,000 C.-M.	3/33	5,000	1,000
550,000 to 1,000,000 C.-M.	4/32	5,000	600

5,000 VOLTS, WORKING PRESSURE.

B. & S. Gauge.	Wall. Inches.	Voltage Test for One Minute.	Insulation Resistance. Megohms per Mile.
No. 4 to 4/0.	6/32	10,000	2,500
250,000 to 500,000 C.-M.	6/32	10,000	1,500
550,000 to 1,000,000 C.-M	6/32	10,000	1,000

11,000 VOLTS, WORKING PRESSURE.

B. & S. Gauge.	Wall. Inches.	Voltage Test for One Minute.	Insulation Resistance. Megohms per Mile.
No. 4 to 4/0.....	9/32	15,000	4,000
250,000 to 500,000 C.-M.	9/32	15,000	3,000
550,000 to 1,000,000 C.-M.	9/32	15,000	1,500
No. 4 to 4/0.....	10/32	20,000	5,000
250,000 to 500,000 C.-M.	10/32	20,000	4,000
550,000 to 1,000,000 C.-M.	10/32	20,000	2,500
No. 4 to 4/0.....	12/32	20,000	6,000
250,000 to 500,000 C.-M.	12/32	20,000	5,000
550,000 to 1,000,000 C.-M.	12/32	20,000	3,000

For railway signaling, fire alarm, telephone and telegraph purposes the walls of insulation should not be less than the following:

B. & S. Gauge.	Rubber Wall. Inches.	Voltage Test for One Minute.	Insulation Resistance. Megohms per Mile.
18	1/16	1,000	3,000
16	1/16	1,000	3,000
14	1/16	1,000	3,000
12	5/64	1,000	3,000
10	5/64	1,000	3,000
8	5/64	1,000	3,000
9	5/64	1,000	3,000
6	3/32	2,000	2,500
4	3/32	2,000	2,500
2	3/32	2,000	2,500
1	3/32	2,000	2,000
0	3/32	2,000	2,000
00	3/32	2,000	2,000
000	3/32	2,000	2,000
0000	3/32	2,000	2,000

ELONGATION TEST.

In addition to the above tests the insulating material of every wire must stand an elongation test of stretching three times its length several times; that is, a piece two inches long must stretch to six inches and promptly return to within twenty per cent of its original length. It must then stretch four times without break or rupture and return to twenty-five per cent of its original length.

This elongation test is intended principally for code wire, and would, even by omitting all conditions as to rubber, compel results that would be entirely reliable and satisfactory for all conditions of code use.

TENSILE TEST.

Any piece of insulation, about one-half-inch wide by one-sixteenth-inch thick, stripped from the completed wire or cable, should stand a tensile strain of 800 pounds to the square inch and stretch to three and one-half times its length without rupture.

The following provision will be found useful: the manufacturer must notify the electrical engineer when wire is ready for testing, and in no instance must shipment be made until notified of approval and acceptance as per above tests.

TESTS.

In carrying out the tests embodied in these specifications there is sought something quite different from the ordinary potential and electrical tests. Heretofore the electrical engineer, when he imposed any test at all, relied solely upon a puncture test. If it met these requirements he asked for nothing more. If a wire or cable withstood a very high puncture test it was looked upon as a *prima facie* evidence of dielectric excellence, forgetting that, had the pressure been maintained a moment longer, the insulation might have broken down. It is a most mischievous practice and a wholly mislead-

ing notion of safety to push a test up to, or even to approach closely the dielectric limit of the insulation; for it is no uncommon occurrence to find the very best insulation hopelessly injured by this practice. It may not be well known, but it is a fact, nevertheless, that it is the rise in temperature which accompanies a rise in potential that is so destructive of rubber insulation. The layers next the copper naturally feel these injurious effects first, and they thus successively carbonize and break down with this increasing elevation of pressure and temperature.

It frequently happens that a cable may pass an exacting puncture test and be to all appearances in first-class condition, when in reality the insulation has been so strained that it collapses at the first physical or potential strain imposed upon it. This is a frequent occurrence. A potential test is not, therefore, in itself, an exact nor even an approximate proof of insulating merit.

You must not, however, assume from this that puncture tests are of no value, for they are, and of great value, but to be of value they must be employed not as a means to destroy merit, but to discover imperfections. Here should be their chief object; and in this respect they are of incalculable importance to the electrical engineer.

It is obvious that a cable may be well made up of very poor material, or it may be imperfectly made up of the very best material. In the one case there is good workmanship with poor material, and in the other bad workmanship with good material. In the first case the cable is intrinsically poor and in the second it is intrinsically good, but imperfectly made up. This imperfection may be slight or considerable; it may be due to a piece of gravel or an air bubble in the compound. In a case like this nothing but a puncture test will discover the fault. But the test should be nominal, and there is no need of pushing it to the point of rupture. If there is any weakness or imperfection, 5,000, 10,000 or 15,000 volts depending on the thickness of the wall of insulation will discover it after one minute's application.

It may be laid down as a safe, general rule that a puncture test should never exceed double the working pressure, but this is true only up to a certain limit, say, 15,000 volts working pressure. After 25,000 to 30,000 volts are reached the temperature increases so fast that it becomes increasingly destructive to the vitality and durability of the insulation.

Much of the present tendency for high potential and breakdown tests is the result of an altogether erroneous comparison with tests imposed on paper-insulated and similar cables, which must, of course, be lead-covered before any test can be made. Such tests are of necessity "dry tests," whereas rubber-covered cables, on the contrary, are soaked in water and tested before the tape, braid or lead is applied. For this reason it is hardly an exaggeration to say that double the potential imposed on a paper cable is no more exacting than half the amount applied to a rubber cable. To expect, then, on a rubber cable anything like the same strain that is ordinarily put on a paper cable would be, in effect, expecting rubber to stand double what paper stands.

In saying this there is no intention whatever to institute comparisons between rubber and paper or detract in any way from the merited recognition accorded to paper for certain work. All that is intended is merely to point out the fallacy of comparing tests that, in their very nature, admit of no comparison.

The specifications and tests here incorporated will, it is hoped, obviate this well-meaning but destructive practice. The really vital point is to make sure of the rubber in the insulation, and this being assured by the tests referred to, all that is needed in the way of a potential test is enough to disclose imperfections arising during the process of manufacture.

The virtue of an insulation test is, as yet, imperfectly recognized by the electrical profession. In fact, engineers in general altogether underestimate the value of a high insulation resistance. It will doubtless surprise many to hear that as a criterion of merit it is immeasurably better than a voltage test. The probable explanation of this seeming paradox is that while a cheap compound will stand initially a high potential test, the current, because of this cheapness, will sneak through it and show a low insulation resistance.

Conversely, then, a high insulation resistance is indicative of a high-grade compound. At any rate this much is certain, that in insulating compounds having thirty per cent fine Para there is always associated with them a very high insulation resistance; whereas in cheap compounds the reverse is equally evident. In code wire, for example, one can not get over 400 or 500 megohms per mile, while the best grade of rubber will show three or four times this amount. A high insulation test should, therefore, wherever possible, always supplement a physical test, as it tends to elevate the grade of the compound. When, however, a chemical analysis is contemplated, the necessity for this is not so obvious; but where it is not the two, if associated, will produce the most satisfactory results.

The reason for limiting the rubber in the compound so as not to exceed thirty-two per cent is this: it was found that by incorporating a large amount of cheap rubber with a small amount of Para the physical test could be nominally complied with, thus defeating the intention of the specification to obtain the best insulation. The object of this limitation, then, is that by not permitting fine Para or any other rubber in excess of this amount the best rubber has to be employed to meet the requirements of the physical test.

Obviously, one manufacturer can not afford to use thirty-five to forty per cent of fine Para at a materially less price than another who uses only thirty per cent; and where an analysis reveals such large amounts or anything in excess of this limitation there can be no doubt whatever as to the inferior grade of rubber used. This provision, then, is extremely important, because with its compulsory observance there would be little need of a chemical analysis at all, except in the event of a dispute, when it could be resorted to as a final court of appeal. The tensile test is, under the limits referred to, sufficiently reliable and adequate for every purpose, for in it we have a means of standardizing rubber insulation that can neither be evaded nor denied.

The Railway Signal Association.

The New York meeting of the Railway Signal Association will be held at the Grand Union Hotel, May 8. The meeting will be called to order at 10.30 A. M. sharp. The revised constitution presented at the Chicago meeting on March 19, and corrected in certain paragraphs, will be considered for adoption.

A paper entitled "The Upward Indication of the Semaphore Arm," by L. R. Clausen, signal engineer, Chicago, Milwaukee & St. Paul Railway, will be read. The following papers will also be presented: "Electric Locking at Electric Interlocking Plants," W. H. Arkenburgh, chief draughtsman Union Pacific Railroad; "Substitution of Track Circuits for Detector Bars," H. W. Lewis, supervisor of signals Lehigh Valley Railroad; "Alternating-Current Track Circuits in the New York Subway," J. M. Waldron, signal engineer Interborough Rapid Transit Company.

Iowa Electrical Association.

The annual convention of the Iowa Electrical Association was held in the Kirkwood Hotel, Des Moines, Iowa, April 18 and 19. The address of welcome was made by Milo Ward, and the response by Austin Burt, president of the association. G. S. Carson, of Iowa City, the secretary of the association, read his annual report, giving various Iowa central station statistics.

The presentation of a Crosby steam indicator was made by Mr. Carson, and it is expected that this will form the beginning of a collection of apparatus which may be utilized by all the members.

J. R. Cravath, Chicago, Ill., presented a report on "Electric Progress During the Year."

D. F. McGee, chairman of the committee on facts and factors, was not able to present a very complete report because of the lack of data available.

O. E. Brownell, Lake City, presented a contribution on the subject of "Ways and Means of Increasing Business in Towns Under 5,000." This paper elicited considerable discussion.

Frank B. Rae, Jr., presented a paper entitled "Modern Advertising Methods," which was read by the secretary.

Following the discussion on the question, "Effect of Boiler Compounds on Engine Lubrication," W. A. Mall, Belle Plaine, read a paper on "The Economy of a Condensing Plant in Small Stations."

J. P. Jones, Cedar Falls; W. J. Green, of Cedar Rapids, and J. A. White discussed the question, "Effect of Day Load on Station Economy."

J. A. Innes, Eagle Grove, contributed a paper on "Line Losses and Economical Distribution," followed by A. W. Zahm, of Mason City, who read a paper entitled "Care and Maintenance of Meters." A paper entitled "Up-to-Date Lightning Protection" was presented by W. P. Caspar.

The subject of "Grounded Secondaries" was presented in two papers, one by H. G. Gorr, of Dubuque, which was read by the secretary, and one by Thomas Sloss.

On Wednesday evening an informal session was held, and the subject of "Some Practical Experience with Steam Turbines" was discussed. Mr. C. E. Stanton presented a paper which was read by President Burt.

On Thursday morning Professor George D. Shepardson, of the University of Minnesota, presented a paper entitled "Technical Men as Dividend Earners."

A paper entitled "The Depreciation of Electrical Properties," by Professor G. W. Bissell, was presented.

The general subject of "Rate Regulation" was discussed in two papers, one by L. G. Hurd, of Dubuque, and the other by George McLean, of Dubuque.

On Thursday afternoon a paper entitled "The Political Status of Rate Regulation," by M. J. Wade, was read.

Mr. Wade's paper was followed by the executive session, and the following officers were elected for the ensuing year:

President—A. W. Zahm, general manager Brice Gas and Electric Company, Mason City.

Vice-president—George S. Carson, manager Iowa City Electric Light Company, Iowa City.

Secretary—L. B. Spinney, Iowa State College, Ames.

Treasurer—W. A. Mall, Belle Plaine Electric Light Company, Belle Plaine.

Executive committee—L. D. Mathes, Union Electric Company, Dubuque; O. E. Brownell, Lake City Electric Company, Lake City; W. N. Kiser, Des Moines Edison Light Company, Des Moines.

The Convention of the Iowa Street and Interurban Railway Association.

The third annual meeting of the Iowa Street and Interurban Railway Association was held at the Kirkwood Hotel, Des Moines, Iowa, April 19 and 20. George B. Hippe, president of the association, presided. Mr. H. H. Polk, president of the Interurban Company, Des Moines, made an address of welcome, which was responded to by President Hippe.

The regular order of business was then transacted, and Mr. John F. Ohmer, Dayton, Ohio, presented a paper entitled "Transfers, Their Use and Abuse." This was followed by a paper on "Discipline of Car Service Employés," by J. G. Huntoon.

A discussion of the testing of rail bonds, fields and armatures was held on Thursday afternoon. The subject was introduced by Roger W. Conant, Cambridge, Mass.

During the afternoon the members met for a brief time with the Iowa Electrical Association and heard the paper on "The Political Status of Rate Regulation," by M. J. Wade.

Mr. F. W. Hild, Dubuque, read a paper on "The Adoption of Gasoline Motors for Street and Interurban Service," on Friday morning.

On Friday afternoon a paper entitled "The Standard Car Body and Truck for Both City and Interurban Service" was presented by G. H. Tontrup, St. Louis.

The paper entitled "Mutuality of Interests of the Operator and the Supply Man," by W. R. Garton, closed the technical session.

The following officers were elected:

President—F. J. Hanlon, vice-president and general manager Mason City & Clear Lake Railway Company, Mason City.

Vice-president—P. P. Crafts, general manager Iowa & Illinois Railway Company, Clinton.

Secretary and treasurer—L. D. Mathes, general manager Union Electric Company, Dubuque.

Benjamin Franklin Statue Unveiled in Paris.

On April 27 the statue of Benjamin Franklin presented to the city of Paris, France, by John H. Harjes, and which stands on the Place du Trocadero, at the head of Rue Franklin, was unveiled. More than 5,000 invitations had been issued, and a brilliant throng of representative Americans and Frenchmen were present at the ceremonies, which began at eleven o'clock in the morning. After an overture by the band of the Republican Guard, United States Ambassador McCormick delivered an address, touching upon Franklin's career as a scientist, philosopher, politician, diplomat, wit and courtier.

Professor Smith, the special representative of the United States government; M. Barthou, minister of public works, and others made brief addresses.

Mr. Harjes formally presented the statue, his granddaughter, Mary Waddington Hope Harjes pulling the rope which released the flag covering the statue. M. Chautard, president of the city legislature, replied to Mr. Harjes, accepting the statue.

Mining and Scientific Press Loses Plant.

The plant of the *Mining and Scientific Press* was entirely lost in the San Francisco disaster. Complete copies of the weekly subscription lists had been taken to Berkeley, Cal., and these very necessary records were not destroyed. The management announces that it has lost its entire mechanical plant, including cuts, halftones, type and the issue of April 21, which had already been set up. Offices have been secured in the First National Bank Building at Berkeley, and through the courtesy of the Standard Publishing Company proper facilities will be secured for printing. It is expected that the management will be handicapped for but a few issues through a scarcity of paper and rush of work at the local photoengraving houses.

Reviews of Current Engineering and Scientific Literature.

Artificial Mineralization of Wooden Ties and Joists.

A new method of treating wooden ties and joists, in order to prevent rot, is described here. It consists essentially in saturating the wood with some salt, say sulphate of copper, which is then decomposed electrically. The wood is first placed in a closed chamber, which is then filled with the sulphate solution, and subjected to pressure, thus forcing the electrolyte into the pores of the wood. It is then taken out and piled up in layers over a concrete reservoir partially filled with the same solution. The first layer of ties is placed on an electrode consisting of a woven strand of copper, upon which is placed a layer of fibrous material, the two layers wrapped with jute. A similar electrode is placed on top of the first layer of ties, and a second layer of ties placed on that, and so on until a considerable pile has been erected, from four to six feet high. Upon the pile heavy blocks are placed so as to bring the ties into close contact with the electrodes. A small pump driven by a motor draws the electrolyte from the reservoir, and by means of distributing pipes sprays it throughout the pile of ties. Alternate electrodes are connected to the opposite poles of an alternating-current supply, and current is allowed to flow through. This, it is said, decomposes the solution, setting free copper all through the pores of the wood. This not only tends to protect the wood itself, but by closing up the pores retains within them a certain amount of copper sulphate, which is a good preservative. This second treatment is necessary to prevent the washing out of the sulphate which would take place were it not applied.—*Translated and abstracted from L'Industrie Électrique (Paris), April 7.*

The Navigable Rivers of France from a Hydroelectric Point of View.

Much has been made of the mountain streams of France in developing electric power. These streams, having their source in the glaciers of the Alps, have been called, poetically, "white coal." In this article M. Henri Bresson considers another type of river as a possible source of power. These are the navigable slow-running streams, and since they are bordered by green pastures and verdant forests, he suggests the name "green coal." The author says that the two types of streams are sufficiently distinct, and that the navigable type is of sufficient importance as a source of power to have a distinctive name. The "white coal" or glacial streams rising in the mountains and depending upon the melting of snow have a greater flow of water during the warm summer months, when power is less needed for lighting. On the other hand, the slow rivers depend mainly upon rains for their water, although they are fed, in part, by the glacial streams; but they have a greater flow of water during the winter, when the lighting load is greatest. Such streams, when available power sites can be found, are therefore most suitable for electric lighting systems. The author supplies a table showing the electric stations driven by rivers, and also gives a map showing the location of these stations. These are, in general, small stations with an output of 200 horse-power or less, though there are one or two considerably larger.—*Translated and abstracted from L'Industrie Électrique (Paris), March 25.*

A New Product of Actinium.

Recent work has attracted attention to the great similarity in the modes of transformation of actinium and thorium. Thorium, probably itself inactive, gives rise to radio-thorium, which emits rays. Radio-thorium forms thorium X, which is followed by the other well-known products, the emanation and the active deposit. Actinium behaves in a similar way, with the exception that heretofore no product intermediate between actinium and actinium X has been noticed. Mr. O. Hahn has, however, detected an intermediate product, which, from analogy, should be called radio-actinium. The separation of this product from an actinium solution in radioactive equilibrium can be accomplished by producing a small precipitate in the solution, which settles down slowly and carries with it the new product, while most of the actinium and the actinium X remain in the solution. Amorphous sulphur is found to be very convenient for this purpose. To a fairly strong hydrochloric solution of actinium some sodium thiosulphate is added, and a small amount of sulphur is allowed to settle down in the cold. This precipitate, after filtration, shows a strong α-ray activity and comparatively little β-ray activity, and gives out very little emanation. The α-ray activity rises steadily to a maximum after about three weeks, and is then about two or three times its initial value. It then decays, according to an exponential law, with a period of about twenty days. Two supplies of actinium were used in these experiments, with the same results in each case.—*Abstracted from Nature (London), April 12.*

A Portable Selenium Photometer for Incandescent Lamps.

A simple and portable type of comparison photometer is described here by Dr. T. Torba. The instrument is constructed primarily to enable lamp users and others who have not had training with the ordinary types of photometers to test their lamps and thus secure a check on their quality, and to enable them to throw out lamps when they have passed their useful age. For this purpose a selenium cell is employed. The cell is connected in a circuit with a milliammeter, a set of dry cells and a controlling key. The selenium cell is normally shaded from the light by a rotatable screen controlled by clockwork, which, when another key is pressed, exposes the selenium to the light from the lamp for two seconds and then closes the opening for forty seconds following. This method is necessary if accurate results are to be obtained, because the resistance of selenium does not fall instantly to its lowest value when exposed to light, but requires some time. Also, time is required for it to recover to the normal dark resistance. These characteristics of selenium have prevented its use for photometric purposes heretofore, but the author thinks that this method of use overcomes all objections. The advantages of such an instrument are: measurements do not depend upon a physiological effect, but are given by the deflections of a direct-reading ammeter. The clockwork control of the screen ensures a uniform period of exposure and of rest, so that reliable results may be secured. The indications of the instrument are not affected by variations in the supply voltage, except, of course, so far as this varies the light given out by the lamp. The resistance of the circuit is high, so that the dry cells form a satisfactory and reliable source of current for the indicating instrument. These cells should be renewed once in three months. A single instrument of this kind can be used in measuring intensities of light from two to thirty-five candles, but the range can be increased by varying

the distance of the light from the instrument, in this way securing a second scale. The instrument is easily calibrated, as all that is necessary is to note the deflections of the ammeter when the cell is exposed to the action of a series of lamps previously rated in a standard photometer.—*Abstracted from the Electrician (London), April 13.*

The Separation of Oil from Feed-Water.

An important problem in electric light and power stations driven by steam power is the separation of the emulsified oil from the feed-water. The various methods used to do this are discussed here by Mr. J. H. Harwood, who thinks that, in general, they are unsatisfactory. The use of baffle plates or scrubbers does not accomplish the end sought. This is particularly true when a high vacuum is desired. Although the baffle plates may stop a good deal of oil, this seems to be free oil, and not the emulsified oil, as the water will leave such separators with the well-known opalescent appearance. Water-jacketing the bodies of separators has been tried without any benefit. At times, when baffling devices are employed, they interfere seriously with the flow of the steam, and thus make it impossible to maintain a high vacuum. Nor are filters, as a rule, much better, for the minute oily globules will pass through any substance which will allow water to pass. There are two systems which give fair satisfaction. In one coagulation is caused by an electric current and in the other by a chemical reaction. The electrical system consists in passing the water, as it comes from the air pump, through a series of wooden tanks, in which are a number of iron plates placed fairly close together and arranged in pairs connected to opposite poles. The current flows from plate to plate through the water, with the result that some oil appears on the surface of the water, while the rest is entangled in a fine red deposit, consisting of oil and iron particles, that can easily be filtered out. It requires about one and one-half kilowatt-hours to treat a thousand gallons of greasy water. There is also some waste from the iron plates. In works where electrical energy is cheap this method has many advantages, but where the necessary current must be bought, chemical treatment, while not so convenient, is cheaper. In nearly every case the means employed is a reagent of ferric alumina or cone alum. This is mixed in a solution of convenient strength and is allowed to mingle in correct proportion with the water of condensation. It requires about one pound of the salt to 5,000 gallons of greasy water. In general, it is necessary to have lime in the water to produce satisfactory coagulation. It is customary to add the make-up feed-water to the condenser water at the same time the coagulating solution is added. After the mixture is affected about half an hour must be allowed for the reaction. It is necessary to have several tanks to receive the greasy water and for treating it. In using the chemical method there is some danger of leaving the water acid, hence it must be tested frequently for an acid reaction, and when this is secured neutralized with potash or any other convenient alkali. It is said that the cost of the chemicals for the treatment is about one-quarter of a cent for each 1,000 gallons of water treated. The apparatus, however, requires more attention than the electrical separator. After coagulation the water should be filtered, preferably through a sand filter having an area of seven square feet for each 1,000 gallons of water per hour passed through. A filter of these proportions must be washed every four or five hours, which is accomplished by passing water through in the reverse direction.—*Abstracted from the Electrical Review (London), April 13.*

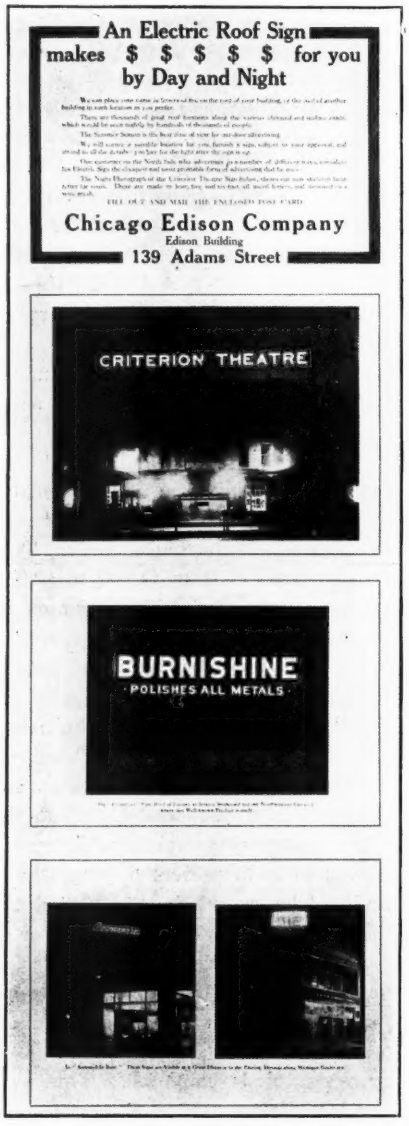
Potential Regulation for Large Electric Furnaces.

The regulation of the current supplied to the small experimental electric furnaces is comparatively easy, but when the amount of power required, and consequently the currents to be handled, became large, the older types of regulators were unsuitable. The smaller furnaces are generally regulated by means of resistances or by taps taken from the secondary of the transformer. This was a convenient system, because the primary was then designed for a constant potential, thus giving a constant induction in the iron core. It gave a minimum weight and therefore a low cost for transforming. For handling heavier currents it is better, says Mr. R. H. Stuart, to place the regulator in the constant-potential primary circuit and then vary the number of primary turns, the currents thereby being reduced to a convenient amount. The secondary turns remain constant, but the induction in the iron core is varied, thus calling for a somewhat larger transformer for a given output. This disadvantage is more than offset by the better design and performance of the regulator. One of the problems met with in the design and operation of the electric furnace is the inherently low power-factor at which the apparatus works. This is due to the very heavy currents and the necessarily large area enclosed by the secondary circuit. To minimize this effect the secondary leads should be composed of a large number of straps so interlaced as to neutralize self-induction as much as possible. The induction regulator might be used for this purpose, but it has been supplanted by the transformer with taps and a regulator. Two installations of this kind are here described by the author. One is employed by the Acheson Graphite Company and has an output of 450 kilowatts. The primary of the transformer has taps which are brought out and connected to a series of manually operated knife switches, the secondary being connected directly to the load. The switches are mounted on a marble panel with barriers, and operated by means of a pole and hook. This is an efficient and simple means of regulation, but it requires a skilled operator and considerable time to pass from minimum to maximum current. A larger outfit, rated at 1,600 kilowatts, has been installed by the Carborundum Company, Niagara Falls. This is operated by a 2,200-volt, twenty-five-cycle circuit. It was desired to obtain a range of secondary potential from 150 to seventy-five volts, and a practically constant current of from 700 to 800 amperes. This gives a current of from 11,000 to 12,000 amperes in the furnace. Taps are brought out from the primary winding of the main transformer to a series of oil switches mounted on a table and operated by a handle. These taps give approximately equal changes in the secondary voltage. Each revolution of the handle changes the connection from one primary tap to the next, a change-over resistance being introduced so as to prevent opening of the circuit. The secondary windings of the transformer are made up of a number of copper straps interlaced, the interlacing being continued in the terminal straps to a point as near the furnace as possible. To secure intermediate voltages an auxiliary regulator is employed. This is a series transformer used in connection with an autotransformer. The series coil is connected in the circuit with the primary of the main transformer. The autotransformer is connected across the supply mains, and by means of a drum controller can raise or lower the voltage developed in the series coil.—*Abstracted from the Electric Journal (Pittsburg), April.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The Generator is the name of a new monthly published at Albany, N. Y., by the Hudson River Electric Power Company. The first issue appeared last month. This bulletin contains a lot of interesting information concerning the plants operated by this company. Numerous illustrations



are presented, and an article of distinct merit describes the work of building the Utica steam turbine plant in ninety days.

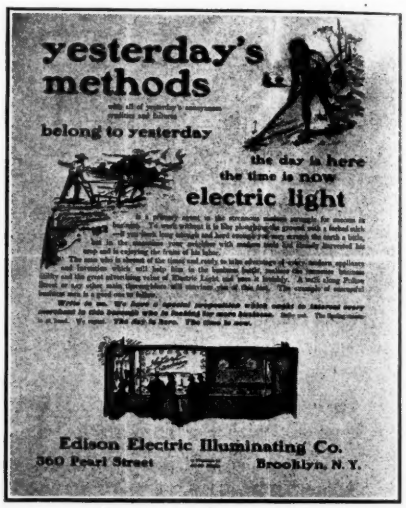
"Yesterday's Methods" is the title of an attractive folder just being distributed by the Edison Electric Illuminating Company of Brooklyn. The stock is a heavy gray cover paper and the printing in brown and black with an added illumination in yellow and black. The story is told allegorically and the conception is very good.

"Making Dollars After Dark" is the title of a folder from the Chicago Edison Company. The stock is heavy white cardboard and the printing in black and red. The folder is striking and attracts attention immediately by reason of its truthfulness. There is no mere promise here. Night photography is utilized to bear in upon the prospect the actual results which have been accomplished by roof lighting. An addressed postal card accompanies this folder.

"We lift your responsibility," says the Philadelphia Electric Company, in a recent neat folder, printed on white cardboard in blue and olive. The type display is excellent and the color scheme very pleasing. The illustration represents a tackle and fall taking the power-house off the arms of (apparently) the owner. The sketch is really not very easy to understand.

The New Orleans Railway and Light Company is distributing a booklet containing a number of illustrations showing the electric illumination at the Mardi Gras, February last. This shows a wonderful development of the use of electrical display not only in the numbers of individual lights, but in the ingenious arrangements and artistic effects.

Recently mention was made of the free trial electric iron proposition made by the Miami Light, Heat and Power Company, of Piqua, Ohio. The Edison Electric Illuminating Company, Brooklyn, N. Y., also offers a free trial of electric irons in order to demonstrate their many advantages. The company guarantees to



inspect the wiring circuit to which the iron is to be attached, and to make such slight alterations as may be deemed essential for the most advantageous installation of the iron. If at the end of the trial period the customer desires to retain the apparatus, a nominal charge will be made for the iron. If not, the company will call for the iron and restore the circuit to its original condition without expense to the customer. The accompanying illustration shows a very attractive folder which the company has recently issued in connection with this offer.

A Folder Announcing a Free-Trial Electric Iron Proposition.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Crocker-Wheeler Company Form "I" Motors and Generators.

The Crocker-Wheeler Company, Ampere, N. J., has placed on the market the form "I" machine, either motor or generator, to meet more fully the requirements of those using electric power than any form previously offered by the company. These machines combine the advantages of the open construction of the earlier Crocker-Wheeler design, having separate base and bearings, with those of the more recent enclosed type designed for floor, wall or ceiling suspension. At the same time the use of enclosing covers provides as much protection as the conditions of operation require. These features, together with the compact design, make these machines especially adapted to machine tool and machine driving, as well as to general purposes.

FULLY ENCLOSED MOTOR, SHOWING SHIELD.

The machines are of the multipolar type, with the round frame, and have feet for attachment to rail base or brackets. The bearings are supported from the frame by strong curved arms.

The machines are ordinarily furnished in the open type, allowing free ventilation and accessibility. The open type of machine can be supplied with grid-iron covers to protect the interior. To give better protection against chips and other flying particles, wire gauze is used in connection with the grid covers. When the machine is to be located in a wet or dirty place, solid metal covers are fitted. The rear covers are held in place by screws and the front covers are securely hinged to the bearing bracket and provided with clamping handles.

The form "I" machines are manufactured in eight sizes, with low and moderate speed ratings for each size. The open grid and gauze-enclosed types are furnished with outputs of three to forty-five horse-power and two and one-half to forty kilowatts. The fully enclosed ratings for continuous service are usually less than for the open type.

The yoke is of cast iron, circular in form, and of compact and graceful design. The bearing brackets are attached to the yoke by cap screws spaced ninety degrees apart.

The poles are of steel, or circular cross-section, cast-welded into the frame. The field coils are carefully wound and insulated, and protected by a moisture-proof covering. The field coils are held in place by the pole shoes, which are fastened by screws to the ends of the poles.

The journal boxes are supported by four-arm bearing brackets attached to the frame. The shaft bearings are of the ring-oiling type. The boxes are accurately and permanently aligned and firmly held in the bearings.

The brushes are held in a brush box and pressed against the commutator by an adjustable spring, which maintains uniform pressure as the brush wears down. The studs carrying the brush-holders are firmly attached to the rocker arm and thoroughly insulated therefrom. The brushes may be shifted simultaneously by rotating the rocker arm on its seat.

The armature core is built up of sheet steel laminations. These laminations are mounted directly on the shaft in the smaller sizes and on a cast-iron spider in the larger sizes. Special attention is given to the ventilation of the core and windings. The coils are of heavy insulated wire, form-wound.

The commutator bars are of hard-drawn copper insulated from each other and from the clamps by the best quality of mica. There are longitudinal ventilating holes in both the core and the commutator.

These machines may be furnished either shunt, series or compound-wound. The leads from the fields and brush-holders are connected to the inner ends of brass studs, which pass through the magnet frame at each side and are insulated therefrom by porcelain bushings. These terminals studs are so arranged that the motors may be connected up for reverse or non-reversing operation.

Belted outfits consist of the motor with rail base, pulley and starter, and the generator with rail base, pulley and field regulator. When required motors may be furnished with countershaft.

The form "I" motors can be furnished for operating with the shaft in a vertical position. The lower bearing bracket of the vertical motor is provided with four finished pads, which are tapped for bolting directly to the machine which the motor drives. If desired the motor can be supported on a stand bolted to the finished pads of the bottom bearing bracket. The lower shaft bearings have flooded lubrication, so that the bearing surfaces run submerged in oil. These bearings take care of the side thrust of gearing or belt, as well as the end thrust caused by the weight of the armature. The upper bearing is of anti-friction metal and will run continuously without attention.

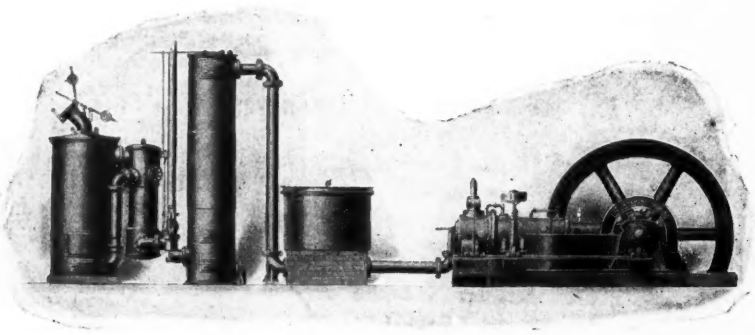
VERTICAL MOTOR.

Quarterly Report of the Chicago Pneumatic Tool Company.

The quarterly report of the president to the shareholders of the Chicago Pneumatic Tool Company for the quarter ending March 31, 1906, shows a profit for the quarter of $233,322.59. After counting off depreciation of buildings, plant and machinery, bond interest for the quarter, sinking fund reserve and quarterly dividend, there is a balance carried to surplus of $94,656.99. The total surplus carried forward is $605,949.14. It is announced that the business for the month of April is about ten per cent in excess of the same period last year. Everything seems to indicate that the year, as a whole, will be a very successful one for the company.

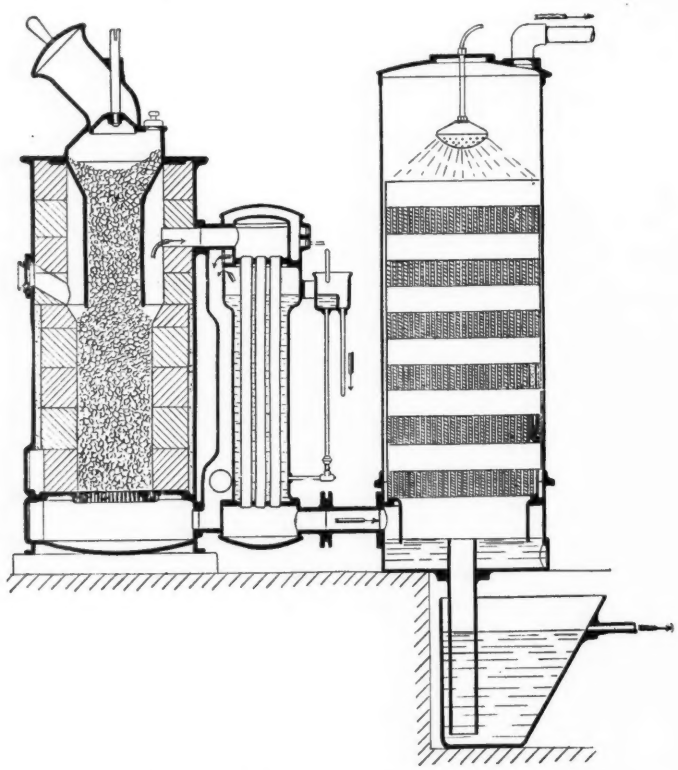
The Koerting Suction Gas Producer.

As the interest for suction gas-producer plants is increasing steadily in this country, a description of the type which is greatly used in Germany and of which many are in successful use, will be of interest. A complete Koerting producer plant and Koerting engine is shown in the accompanying illustrations.



Suction Gas-Producer Plant and Gas Engine.

The producer is a plain vertical steel shaft, cylindrical in form and lined with firebrick. It is provided with large cleaning doors near the bottom and with poke holes on top. A bell hopper is used for charging coal.



Details of Gas Generator and Scrubber.

The evaporator which is used for generating the necessary steam is arranged similar to a tubular boiler, the heat of the gas going from the producer to the scrubber, being used for raising the necessary steam.

The scrubber is filled with coarse pieces of coke which are sprinkled with water. The gas is washed by this water in going upwards through the scrubber.

The sawdust purifier is an ordinary tank with two wooden trays which are covered with shavings and sawdust. In going through these layers the gas is filtered so that it reaches the engine in an absolutely pure state. The engine is of the horizontal type, is built especially heavy for the use of producer gas and runs at slow speed.

It is provided with a special mixing valve operated automatically by the incoming components of gas and air, which components are thoroughly mixed before they are admitted to the cylinder.

In running, this engine receives an impulse every two revolutions. No charges are missed, but the size of each charge is closely proportioned to the amount of work to be done. This fact, combined with the advantages to be gained from a perfect governor and mixing valve insures close regulation on all loads, and enables the engine to satisfy the most exacting requirements.

A seventy-five horse-power plant of this kind is now running at the shops of the De La Vergne Machine Company, New York, and is developing steadily one brake horse-power-hour with less than one pound of coal.

Recent Endurance Test of Gas Producer.

Some skepticism having been expressed as to the claims made by the fuel-testing committee of the United States Geological Survey regarding the power-producing efficiency of coals used in the gas producer and gas engine, a so-called "endurance test" was recently undertaken by Professor R. H. Fernald, who has charge of the survey's gas-producer plant at St. Louis. The results of this run, which began March 28 and continued until April 21, a period of twenty-four consecutive days, are particularly valuable and suggestive. They afford indisputable proof of the possibility of operating producer plants continuously for power purposes with the use of bituminous coals.

This test was made possible through the courtesy of Donk Brothers Coal and Coke Company, of St. Louis, who generously supplied, without charge to the government, 150 tons of screened coal from their mine "No. 3," located near Troy, Ill. The average of six analyses of this coal showed 14.68 per cent moisture, 30.98 per cent of volatile combustible, 42.93 per cent of fixed carbon and 11.41 per cent of ash, including 1.33 per cent of sulphur. The British thermal units per pound of dry coal were 12,343.

This test was made in the plant in which all the government fuel tests have been conducted since October, 1904. This installation consists of a Taylor pressure producer-gas plant of 250 horse-power capacity, furnished by R. D. Wood & Company, of Philadelphia, and a vertical three-cylinder, single-acting Westinghouse gas engine of 235 brake-horse-power capacity, operating on producer gas. The engine is belted to a 175-kilowatt Westinghouse generator. The electrical energy developed

during this test was dissipated through a water rheostat, designed to readily control the load upon the engine.

The coal was broken to about three-inch egg size and delivered to the charging floor of the producer by a belt conveyor. It was charged to the producer at intervals varying from twenty-five to thirty minutes. The weight of each charge was 150 pounds. The hopper through which the coal passed to the producer is a double seal hopper with belt and cover plate. The producer was charged by hand. The bell is so designed that the coal is evenly distributed over all portions of the fuel bed, which was kept in uniform condition by hand-poking from the top about every half hour.

The gas left the generator at an average temperature of 644 degrees Fahrenheit and passed through a water-seal dust collector and then to the scrubber. From there the gas passed directly to a centrifugal tar extractor which removed the greater portion of the tar left in the gas. It was then delivered directly to the holder. No further attempt was made to purify it, since experiments at this testing plant have proved conclusively that sulphur carried in the gas has no injurious effect upon the engine. From the holder the gas passed through a meter which has a capacity of 30,000 cubic feet per hour, on its way to the engine cylinders.

During this entire test calorimetric determinations of the heat value of the gas were made every twenty minutes and volumetric analyses were made every two hours. The average heat value of the gas for the entire run was 156.1 British thermal units per cubic foot. This gas contained no hydrogen disulphide, 9.2 per cent carbon dioxide, no oxygen, 0.4 per cent ethylene, 20.9 per cent carbon monoxide, 15.6 per cent hydrogen, 1.9 per cent methane and fifty-two per cent nitrogen.

Observations relating to the tar extracted during this test are of special significance, as it has often been stated that no plant which separates the tar mechanically could run more than five or six days without shutting down. The total tar extracted during this test amounted to 14,950 pounds or about 143 pounds of tar for every ton of coal burned in the producer. This tar did not contain over ten per cent of water.

As the plant was designed for general test purposes, the passages through which the gas was obliged to pass were far more tortuous than would have been the case in a plant installed merely for the production of power. In passing from the dust collector to the scrubber, the gas was forced to make three right-angle turns and pass through a water-seal valve, traversing a distance of about twenty feet instead of three feet, as would have been the case in an ideal arrangement. Owing to the deposit of tar in the water-seal valve, the test was brought to a close after twenty-four days. Without this unfortunate combination of piping, more notable endurance records should be made than the surprising twenty-four-day test here recorded.

The ashes were removed about once every forty-eight hours without shutting down the plant. This was accomplished by simply reducing the pressure under which the producer was operated, and running the plant on the suction basis during the hour required for removing the ashes. The men worked with entire ease and comfort during this period.

The engine ran in perfect order at all times during the period of twenty-four days and at the end of the test was found in unimpeachable condition. Even a cleaning was not necessary. It is still operating with remarkable regularity and shows no ill-effects from the strain to which it was subjected. The producer plant was also found in excellent condition, and the regular tests are now going on as usual.

Owing to the fact that final calibrations of some of the instruments used in this test have not been received, the official horse-power carried during the test and the dry coal required per brake-horse-power per hour can not be given. The approximate figures show, however, that an average horse-power of 227 was used during the test, and an average of 1.39 pounds of dry coal consumed per brake-horse-power per hour.

Gas Engines for Railway Service.

The Westinghouse Machine Company, of East Pittsburg, Pa., has recently contracted with the Olean Street Railway Company to install in its power-house at Ceres, N. Y., two gas engines for supplying current to the Olean Street Railway, serving Olean, Ceres, Boliva and other towns. In the near future power will also be supplied to an interurban railway system between Olean and Salamanca, N. Y., a distance of fifteen miles.

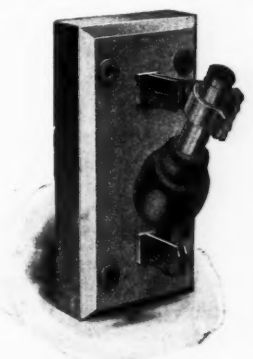
The engines are to be of the Westinghouse horizontal, heavy-duty, double-acting type, with single cranks, and cylinders twenty-two inches in diameter by thirty-inch stroke. Each unit will have a normal capacity of 500 brake-horse-power, running at 150 revolutions per minute. They will operate on natural gas having a calorific value of approximately 1,000 British thermal units, which fuel is very plentiful in that territory.

The engines are to drive 300-kilowatt, twenty-five-cycle alternating-current generators, operating in parallel and supplying current at 380 volts to a high-tension, three-phase transmission distribution system through step-up transformers.

At present the Olean Street Railway Company has a steam power plant in service burning gas under boilers, and a large saving is contemplated in using gas power.

General Electric Company's Fuse Holders.

The General Electric Company, Schenectady, N. Y., has perfected a new device in the shape of a high-potential fuse holder. These fuse holders are designed to protect 2,300 and 6,600-volt systems, but can be made to suit special requirements for higher voltage. They supersede the "expulsion" type and will be used in the future on all General Electric switchboards requiring high-potential fuses. The device is of small size and is said to be capable of rupturing more energy under short-circuit conditions than any other similar device heretofore placed on the market.



New G. E. Fuse Holder.

The body of the holder consists of an insulated metallic chamber, into the upper end of which is screwed a fibre tube. That part of the fuse located in the chamber is of smaller cross-section than the remainder to ensure rupturing at that point. The expansion of the gases formed by the arc in the chamber expels the fused metal and effectually opens the circuit.

New fuses can be readily inserted in the holder by removing a screw plug located in the bottom of the bulb.

The holder is connected in circuit by means of blades fastened to either end, which fit into clips mounted on a base or switchboard panel. The advantages of this method of support will be readily understood. Spare fuse holders can be kept

on hand ready for the instant replacement of ruptured fuses.

The complete device is compact, substantial, easy to handle, and may be located in any convenient place. The holders can be supplied in groups of two, three or four, mounted on bases or in single elements without bases for switchboard mounting.

It is recommended that 2,300-volt holders be spaced on twelve-inch centres and 6,600-volt holders on eighteen-inch centres, unless barriers are used between them, in which case these distances can be made five inches and eight inches, respectively.

The ampere rating corresponds to the continuous-current carrying capacity, and the rupturing point is approximately sixty per cent greater. Fuses for operating on small overloads can be made to order.

The 2,300 and 6,600-volt fuse holders are made to carry 100 ampere fuses or smaller sizes. Holders of both voltages are furnished back-connected for switchboard use without bases and either back or front-connected on base singly or in groups with barriers.

New Type Direct-Current Wattmeter.

The latest type of Duncan direct-current wattmeter possesses a number of advantageous features peculiar to itself, and demonstrating a great deal of forethought and study in the development of the instrument.

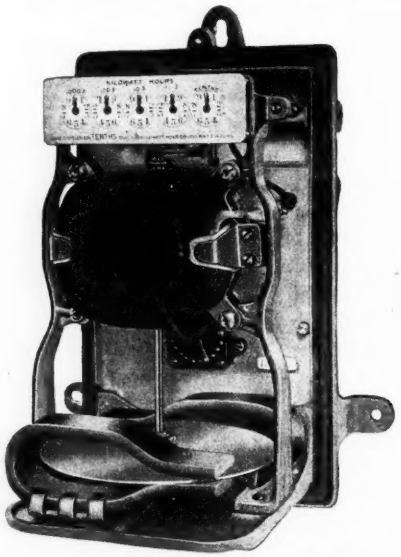
These meters are now guaranteed to have a driving torque of not less than 200 millimetre grammes. This is said to be twenty-five per cent higher than any heretofore used—that is, for a five-ampere size. The larger instruments have a correspondingly greater torque. The company claims that this meter is able to accurately measure small loads under an absolute guarantee.

The magnets have received special attention and are being put through an entirely new method of artificial aging, so that when they are assembled in the meter the maker guarantees them not to vary two per cent in three years, under normal conditions. An interesting test recently made on a five-ampere meter consisted in short-circuiting it through a twenty-ampere fuse, or 300 per cent above its capacity. After this operation had been repeated about ten times the meter was tested, and the magnets were found to have lost only about two per cent of their original magnetism.

The present design also embodies the visual bearing, which is owned by this company, and which has proved itself very popular with meter engineers. This design enables a thorough inspection of the lower spindle point and sapphire jewel while the meter is in operation. This is a great saving of time, as it facilitates the removal and insertion of either or both the jewel and spindle point.

Another feature of this meter is the switch method of compensating for friction and vibration. Any range of compensation can be secured by the simple movement of a small lever over the contacts of a multi-point switch; and when once set and adjusted to conform to the immediate condition of affairs it is particularly rigid and reliable, and there is no tendency of its being thrown out of calibration by short-circuits or rough handling.

This meter is manufactured by the Duncan Electric Manufacturing Company, Lafayette, Ind. The company is also placing on the market a new line of meters specially adapted for measuring the energy delivered for heating purposes, such as is supplied to cooking utensils. These meters have special registering trains, reading in British thermal units. They are meeting with much success.



DUNCAN STANDARD WATT-HOUR METER.

The company expects to have ready in about sixty days a new line of discount meters which are absolutely automatic in their operation and take care of a sliding scale of discounts, depending upon the amount of energy consumed. For example, the instrument can be set to automatically accomplish the following: when ten kilowatt-hours have been consumed a discount of ten per cent will be given for the succeeding ten kilowatt-hours, and when twenty kilowatt-hours have been consumed an additional ten per cent will be automatically given on the third ten kilowatt-hours, and so on.

An additional line of prediscount meters is also in preparation, which will be utilized in cases where discounts are given to special customers for power service. By a simple device within the meter the central station manager can set it for any predetermined discount which may be decided upon between his customer and himself. This eliminates the trouble and difficulty of taking care of various discounts, as it becomes a matter of taking the actual reading of the meter and using one rate per kilowatt-hour for all customers.

Another special line of meters which the Duncan Electric Manufacturing Company is ready to furnish is equipped with registering trains showing the equivalent of the amount consumed in dollars and cents.

The accompanying illustration shows one type of the company's standard kilowatt-hour meters.

CENSUS OF MANUFACTURES, 1905.

ELECTRICAL MACHINERY AND APPARATUS.

The director of the census announced to-day the result of the tabulation of the statistics of electrical machinery and apparatus for the calendar year 1904, forming a part of the census of manufactures of 1905, taken in conformity with the Act of Congress of March 6, 1902. The figures indicate that there has been a substantial increase in this industry in the United States, as compared with the statistics of 1900, which covered the fiscal year ending May 31.

Comparative figures for 1905 and 1900 are shown in the following summary:

	1905.	1900.	Per cent of Increase.
Number of establishments	783	580	35.0
Capital	$191,469,874	$83,130,943	130.3
Salaried officials, clerks, etc.:			
Number	11,590	4,987	132.4
Salaries	$11,675,576	$4,563,112	155.9
Wage earners:			
Average number	59,336	40,890	45.1
Wages	$31,226,721	$20,190,344	54.7
Miscellaneous expenses	17,934,878	6,788,314	164.2
Total cost of materials used	66,728,176	48,916,440	36.4
Total value of products	140,614,481*	91,348,889	53.9

*Exclusive of $17,335,033, reported as by-products of other industries, the aggregate value of electrical machinery and apparatus production for 1905 being $157,949,514.

The principal products are summarized as follows:

Dynamos	$11,084,234	$10,472,576	5.8
Motors	22,370,626	19,505,504	14.7
Carbons	2,710,935	1,731,248	56.6
Incandescent lamps	8,319,159	4,036,112	106.1
Telephone and telegraph apparatus	16,974,892	12,154,678	39.7
Insulated wires and cables	34,519,699	21,292,001	62.1
All other products	59,171,047	33,490,464	76.7
Custom work and repairing	2,798,922	2,063,736	35.6
	$157,949,514	$104,746,319	50.8

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

PUBLIC HEARING ON FRANCHISE FOR ATLANTIC TELEPHONE COMPANY—On May 11 a public hearing will be held by the Board of Estimate and Apportionment in New York city, on the application of the Atlantic Telephone Company for a franchise to operate a telephone system in the city.

CHARTER GRANTED FOR A SUBWAY SYSTEM IN PITTSBURG, PA.—A charter has been granted to the Pittsburg Subway Company to construct a tunnel one mile long beneath the principal streets in down-town Pittsburg, Pa. It is understood that this charter conflicts at some points with rights which have already been given to the Flinn Company, granted under the name of the Freight Tunnels Company.

TELEGRAPH, TELEPHONE AND CABLE COMPANY RECEIVER—Charles Myers, of Newark, N. J., has been appointed receiver for the Telegraph, Telephone and Cable Company of America. The company is incorporated for $30,000,000. The liabilities are placed at $925,562, which is composed of unpaid assessments. The bill states that the company has a number of subsidiary companies which are inactive.

VIRGINIA ELECTRIC PLANT MERGER COMPLETED—The merger of all the electrical traction, light and gas properties in Norfolk, Portsmouth, Berkeley and Suffolk, with the exception of the Bay Shore Terminal and Norfolk & Atlantic Terminal properties, into the $14,000,000 holding corporation known as the Norfolk & Portsmouth Traction Company, has been finally completed, and the merger becomes effective from June 1.

MEXICAN STREET RAILWAY DEAL—The Canadian syndicate which recently purchased the electric railway lines in Mexico City has entered the city of Puebla, where it has purchased the properties of the Puebla Tramways Company. The system in that city will be electrified, and additions will be made to the line. It is probable that the electrical undertaking in Puebla will be organized under a separate company, and it is expected that some $6,000,000 will be expended in improvements.

ELECTRICAL SECURITIES COMPANY TO BE ORGANIZED—It is announced that an electrical securities corporation is to be organized, which, besides having a cash capital of several million dollars, will own all the stock of Westinghouse, Church, Kerr & Company. This corporation, besides conducting a general engineering and construction business through Westinghouse, Church, Kerr & Company, will also make investments in enterprises involving the use of electricity. John F. Wallace is to be the president of the company, and his principal associates in the management have already been selected.

AN EXTENSIVE POWER CANAL ENTERPRISE—A company has been formed to build a canal from a point on the Niagara river at La Salle to the Devil's hole, where a power-house capable of generating 200,000 electrical horse-power will be built. It is proposed to make the canal navigable for lake boats. It is the intention of the company to deepen the channel of the Niagara river from Tonawanda to the falls to accommodate vessels of the same draught which touch at the port of Tonawanda. Along the canal it is proposed to install industrial plants, among which will be a large steel plant. The power canal will be 200 feet wide and eighteen feet deep.

CHICAGO WINS IN TUNNEL TAX CASE—In a decision involving the power of the Chicago board of assessors to assess the franchises of the Illinois Tunnel Company in the street, the Supreme Court of Illinois has decided in favor of the city. The Illinois Tunnel Company was assessed last year $1,500,000 on its tangible property. Under this decision and mandamus proceedings the board of assessors will be compelled to increase the assessed valuation to $15,000,000 or $20,000,000. It is also announced that the precedent set applies as well to the gas company, the electric lighting companies, the telephone companies, the telegraph corporations and the street railways.

RAPID TRANSIT SUBWAY ESTIMATES—Testifying before a commission appointed to hold public hearings as to the necessity of building on several routes designated by the Rapid Transit Commission, City of New York, as provided by law, George S. Rice, chief engineer of the permanent commission, gave the estimated cost of all the subways on the nineteen routes approved by the commission as $450,000,000. He said that a subway in Third avenue would cost $39,000,000 and would probably carry 600,000 passengers a day. A subway up Seventh and Eighth avenues, he said, would cost $40,000,000. Cost of municipal operation he estimated at sixty per cent of gross receipts, while the present subway is being operated by a private corporation at fifty per cent.

NEW OREGON POWER PLANT—Contracts have been let for building what will be one of the largest power development plants in Oregon, on the Deschutes river, at a point near Shear bridge, about thirty miles south from The Dalles. This project, which is under direction of the Interior Development Company, contemplates the development of 50,000 horse-power for the generation of electricity, and it will cost in the neighborhood of $200,000. A. Welch, of Portland, is president of the Interior Development Company, which was incorporated recently, and E. P. McCornack, of Salem, is secretary. A contract for all work has been awarded to Van Dyne & Brown, of the Tygh Valley Company, and a force of men has already begun building bunkhouses and tool sheds, preparatory to starting the construction of the dam across the Deschutes. When all is in readiness, all the available labor in that section will be put to work on the big dam.

NEW COMPANY TAKES OVER LINES—For the purpose of taking over the Appleyard lines the Indiana, Columbus and Eastern Traction Company was incorporated in Columbus recently by W. Kelsey Schoepf and others with a capital stock of $1,000,000. This company will take over the Tucker-Anthony and Appleyard roads, recently acquired by the Schoepf syndicate. These extend from Zanesville, through Columbus, Springfield and Dayton to Richmond, where they connect with the Indiana properties of the Schoepf syndicate, thus making a through traction line between Zanesville and Terre Haute. This will make the longest operating traction company in the country. Mr. Schoepf has announced that the new company will build a line between Dayton and Richmond. All negotiations for the purchase of the Dayton and Western have been dropped, and a new road will be built, following the National pike.

KINGS RIVER, CAL., TO BE HARNESSED—Over $8,000,000 will be spent in the development of power on the upper waters of the Kings river by a syndicate known as the Kings River Power Company, and backed by E. H. Rollins, of Boston, and N. W. Harris & Company and Ladenburg, Thalman & Company, of New York. There will be four separate plants, each to cost $2,000,000. The first will be on the river between Trimmers and Maxons, to which point the county road already reaches. The second will be at the junction of Mill Creek with the river; the third at the junction of the Middle and South Forks, and the fourth at the junction of Boulder Creek with the South Fork. The latter point is the final point of the Ellery survey for the state highway. Already the corporation has a large force of men at work building thirty miles of rock ballasted highway at a cost of over $100,000 from Trimmers to the junction of the Middle and South Forks. According to F. C. Finkle, chief engineer of the company, all the power to be developed is to be used in the San Joaquin Valley's development.

ELECTRIC LIGHTING.

ST. PAUL, MINN.—Farmington has granted an electric lighting franchise.

NORWOOD, MASS.—Norwood has appropriated $25,000 for installing an electric light plant.

GARFIELD, N. J.—The Garfield Council has signed a five-year contract for lighting with the Public Service Corporation.

PRATT, KAN.—The common council of Pratt has granted a twenty-year franchise to the Pratt Ice and Light Company.

ALVIN, TEX.—An electric-lighting franchise has been granted to Henry Womole and H. H. Ford. Work must begin within six months.

TRUMANSBURG, N. Y.—The electric plant located at Tayhanic Falls is now in operation, furnishing light and power to Trumansburg, Interlaken and Ovid.

MACKAY, IDA.—The Big Lost River Mining Company, Limited, has been granted a franchise by the Mackay city council to construct an electric lighting system.

CANTON, OHIO—The Canton Light, Heat and Power Company was the successful bidder for the contract for lighting the Canton city streets. A ten-year contract was granted.

SPRINGFIELD, ILL.—The Pecatonica River Power Company, of Freeport, has certified to the secretary of state an increase of capital stock from $5,000 to $100,000.

LINTON, IND.—At a meeting of the city council the city attorney was instructed to prepare an ordinance looking to the sale of the municipal light plant to the highest bidder.

NIAGARA FALLS, ONT.—The plans of the Niagara-Welland Power Company for its transmission line for Niagara power to western Ontario have been filed in the Guelph registry office.

SUMPTER, ORE.—By unanimous vote the Sumpter council has granted the Oregon Electric Power Company the franchise sought to supply Sumpter and vicinity with electric light and power.

PITTSTON, PA.—The Pittston Light, Heat and Power Company has been awarded the contract to light the streets of Pittston for a term of five years. The price for arc lamps is $50 per annum and $17 for incandescent lights.

ERIN, TENN.—A franchise has been granted to the Erin Electric Light and Illuminating Company by the Quarterly County Court for a period of ninety-nine years, to establish and maintain an electric light plant at Erin.

HYATTSVILLE, MD.—By a vote of ninety-eight to eighty-five the bill recently submitted by the state legislature, to authorize the mayor and council of Hyattsville to issue bonds in the sum of $12,000 for the installation of an electric lighting plant, was ratified at a special election.

SPRINGFIELD, OHIO.—A deal is being fostered by which the People's Light, Heating and Power Company, owned by Columbus men, and the Home Light, Heat and Power Company, owned by E. S. Kelly, are to be merged and controlled by a new company which is being organized.

PROVIDENCE, R. I.—The Wickford Light and Water Company, having purchased all rights from Stillman Saunders, Browne Lockwood, Walter Greene and S. P. Kelly, will establish an electric lighting system at Saunderstown that will be in operation by the opening of the coming summer season.

UTICA, N. Y.—At the annual meeting of the Utica Gas and Electric Company the following were chosen directors: Anthony N. Brady, William E. Lewis, Samuel A. Beardsley, John F. Maynard, Charles S. Symonds, Charles B. Rogers, William T. Baker, M. Jesse Brayton and Winthrop Coffin, of Boston.

WEST UNITY, OHIO—The Electric Light company stockholders have elected the following directors: A. M. Miller, J. H. Miller, Charles Arnold, J. A. Hollington, W. H. Held, L. I. Charpiot, L. L. Mann. They elected: president, A. M. Miller; vice-president, J. A. Hollington; secretary and treasurer, L. P. Charpiot.

NEW WESTMINSTER, B. C.—H. M. Burwell has been granted 25,000 inches of water in the Lillooet river. Mr. Burwell appeared on behalf of the Burrard Flume company. This concern intends to locate large power works at the point where Kanaka creek runs into the Fraser river, a short distance above Port Haney.

KANSAS CITY, MO.—The city council at Poteau has granted a twenty-year franchise to R. C. Alexander, of Abeline, Tex., for an electric light and power system in that city. The Fort Gibson light plant has been purchased by P. L. Pyle, and the plant will be enlarged at once to meet the requirements of the town.

CINCINNATI, OHIO—The Cincinnati Light, Heat and Power Company, the recently-incorporated company which is to apply for a franchise to supply electricity to users in that city, has been formally organized. The officers are: president, H. H. Bechtel; secretary-treasurer, C. W. Cole. The directors are Cyrus E. Mead, E. R. Stearns and G. W. Mallon.

PATERSON, N. J.—Announcement was made at the annual meeting of the directors of the Public Service Corporation in Newark that cheaper rates for electricity and gas will prevail. After May 1 the rate for electricity will be reduced to twelve cents a kilowatt-hour through Essex, Hudson and Passaic counties. The present rate is thirteen cents.

DENVER, COL.—The Denver Gas and Electric Company has determined to ask of the people a new twenty-year franchise, undertaking to pay to the city therefor the sum of $1,000,000 in quarterly instalments, and to reduce its charges for electric light, beginning with nine cents per kilowatt-hour. The ordinance will be submitted to a vote of the qualified electors.

OTTAWA, KAN.—By a vote of six to one the city of Ottawa decided to take over the municipal water and electric light plant. Bonds in the sum of $150,000 were authorized for purchase and improvement. Seventy thousand dollars of this goes for purchase. All the negotiations are concluded for the purchase and the transfer will probably be made in sixty to ninety days.

PHILADELPHIA, PA.—Pittsburg men are said to have been looking over the field with the view of establishing a large electric light plant to furnish light to the towns between Wilmerding and Derry, along the Pennsylvania Railroad, and power for trolley lines and other purposes. It is stated the company has had inducements enough to launch the venture, which will call for the expenditure of at least $600,000.

DARBY, PA.—At a meeting of the Darby borough council the ordinance granting the franchise for the erection of an electric light and power plant was adopted on final reading. The Philadelphia Suburban Electric Light Company promised to formulate plans without loss of time. It is provided in the ordinance that ten arc lights are to be given to the borough free and that the fixed rate to private consumers shall be low.

LANCASTER, PA.—The electric plants of the Lancaster Valley Electric Company, at Manheim and Mount Joy, have been sold by the Commonwealth Trust Company, trustee of the first mortgage bonds. The bonded indebtedness, with accrued interest, is about $65,000. The plants were bought by C. T. Leland and Dr. Henry V. H. Stoever, of Philadelphia, for $20,800. The bond-holders will get a twenty-five per cent dividend on their investment.

MARTINSVILLE, VA.—At a recent meeting of the Martinsville town council the rates at which electric power and lights are to be sold were fixed upon a sliding scale, ranging from $20 per horse-power to parties taking as much as seventy-five horse-power, up to $42.50 per horse-power to parties taking one horse-power. Lights range from twenty cents per month each to parties taking ten or more up to fifty cents per month to those taking one light. The city engineer expects to have the plant in operation early in May.

DENVER, COL.—The Northern Colorado Power Company, which has purchased a coal mine at Lafayette and will build an electric power plant at that town for the purpose of supplying the towns and mines in northern Colorado and the southern part of Wyoming with light and power, has been incorporated and the plant will soon be erected. It is believed that the McMillan syndicate, which owns the Denver Gas and Electric Company, the Pueblo lighting plant and several plants in the East, is backing the proposition.

PERSONAL MENTION.

MR. MAX LOEWENTHAL, the well-known consulting electrical heating engineer delivered a lecture on "Household Uses of Electricity," before the Stevens Club, of Newark, N. J., on Friday evening, April 27. During the lecture a number of articles were cooked by the electrical utensils.

MR. MANUEL M. REID has been appointed superintendent of the city lighting plant, Columbus, Ohio. Up to a little more than a year ago Mr. Reid was master mechanic of the Appleyard lines, with which he was connected for five years. Previously he had been master mechanic for the Atlantic & Danville Railway, and before that, division master mechanic for the Norfolk and Danville divisions of the Southern Railway.

MR. ALEXANDER B. HENDERSON'S daughter, Miss Ella McLeod Henderson, and Mr. David Joseph Gilmartin were married on Wednesday of last week at the Church of the Holy Name, Ninety-sixth street and Amsterdam avenue, New York city. There was a large attendance of friends at the church, and a reception followed at Mr. Henderson's residence in West 103d street, at 8 P. M., the marriage taking place at 7.30 P. M. Mr. Henderson is connected with the American Circular Loom Company, and has a wide acquaintance in the electrical field.

MR. MARSDEN J. PERRY, president of the Narragansett Electric Lighting Company, Providence, R. I., is a director of the new Night and Day Bank, which opened its doors for business in New York city on Monday, April 30, at the corner of Fifth avenue and Forty-fourth street. Mr. John C. Tomlinson, the well-known attorney, is also a member of the board of directors, and Mr. G. L. Wilmerding, brother of Mr. C. H. Wilmerding, of Chicago, formerly president of the National Electric Light Association, is night manager. The bank is to be open at all hours, night and day, except Sundays and holidays. It starts business with a capital of $200,000 and a surplus of the same amount.

MR. JOHN J. MAGILTON, auditor of the Schenectady (N. Y.) Illuminating Company and the Mohawk Gas Company, has resigned, and in a short time will take up his duties as assistant to President E. L. Ashley, of the Hudson River Water Power Company, with offices at Albany, N. Y. Mr. Magilton went to Schenectady, January 1, 1900, as auditor of the Schenectady Railway Company and the Schenectady Illuminating Company. He is a member of the National Street Railway Accountants' Association, and has been vice-president and a member of the executive committee for two terms.

MR. JOHN C. REILLY, who was recently elected vice-president of the New York & New Jersey Telephone Company, was presented with a handsome Jurgenssen watch, with chain and charm, and a chest of silver, on Saturday, April 14, by fifteen or twenty gentlemen, representing the various departments of the New York & New Jersey Telephone Company, who had served under the direction of Mr. Reilly during his capacity as general manager. The presentation was made in Mr. Reilly's office at 81 Willoughby street, Brooklyn, N. Y., Mr. Frank W. Conn, division plant superintendent, making the presentation on behalf of his associates. Mr. Reilly was taken completely by surprise, but recovered himself sufficiently to make an appropriate reply to the complimentary speech made by Mr. Conn. The matter was so quietly and carefully handled that none of the people of the departments other than those who had formerly reported to Mr. Reilly had any knowledge of the fact that the presentation was to be made. After the presentation the delegation individually expressed to Mr. Reilly their regrets at the severance of their personal relations by virtue of the recent changes.

MR. JOHN C. REILLY.

ELECTRICAL SECURITIES.

The declines initiated by the news of the San Francisco disaster kept up with more or less consistency during the past week. The fall in the price of United Railroads of San Francisco and other tractions accompanied a decline in the speculative value of Consolidated Gas, due to the latter's lessened dividend announcement. The stimulation which has taken place, however, in the matter of rebuilding the devastated city, it is thought, will bring values to a normal condition. The report for the March quarter from the United States Steel Corporation reflects a very satisfactory condition of affairs, and is an index of the general prosperity and continued activity in that industry. This is, by the way, a more or less accurate indication of the general state of affairs industrially, and points to the undisputed fact that the inherent stability of investment is greater to-day than at any previous time in the history of the country.

ELECTRICAL SECURITIES FOR THE WEEK ENDING APRIL 28.

New York:	*Closing.*
Allis-Chalmers common	20
Allis-Chalmers preferred	50
Brooklyn Rapid Transit	73
Consolidated Gas	133
General Electric	162½
Interborough Rapid Transit	222
Kings County Electric	160
Mackay Companies (Postal Telegraph and Cables) common	61½
Mackay Companies (Postal Telegraph and Cables) preferred	71½
Manhattan Elevated	150
Metropolitan Street Railway	109¾
New York & New Jersey Telephone	141
Western Union	92¾
Westinghouse Manufacturing Company	150

The stockholders of the Interborough Rapid Transit Company will hold their annual meeting in New York city on May 9. At a special meeting of the stockholders on April 27, the proposed amendment of the charter dividing the directors into three classes, to hold office one, two and three years, respectively, was adopted.

The directors of the Consolidated Gas Company have declared a quarterly dividend of 1 per cent on the capital stock, payable June 15. This is a reduction of 1 per cent from the previous payment made March 15 last.

Boston:	*Closing.*
American Telephone and Telegraph	135
Edison Electric Illuminating	245
Massachusetts Electric	66
New England Telephone	138
Western Telephone and Telegraph preferred	89

Coupons from the 5 per cent, three-year gold coupon notes of the American Telephone and Telegraph Company, by their terms payable on May 1, 1906, at the office of the treasurer in the city of New York, or, at the holder's option, at the office of the treasurer in the city of Boston, will be paid in New York by the Manhattan Trust Company, 20 Wall street, or in Boston by the National Bank of Commerce, Sears Building.

The income account of the Massachusetts Electric Companies for the quarter ended March 31, 1906, is as follows: gross, $1,458,399; expenses, $1,103,037; net, $355,362; charges and taxes, $407,398, leaving a deficit of $52,036; reserve, $38,802; total deficit, $90,838, as compared with $221,638 for the corresponding quarter of 1905.

Philadelphia:	*Closing.*
Electric Company of America	11¼
Electric Storage Battery common	69¾
Electric Storage Battery preferred	69¾
Philadelphia Electric	7⅞
Philadelphia Rapid Transit	25⅞
United Gas Improvement	91¼

The Electric Company of America has issued its annual report for the year ended December 31, 1905. The income account is as follows: total income, $539,190; charges to subsidiary companies, $42,654, leaving a balance of $496,536; expense of management and dividends, $341,110, leaving a surplus of $285,505; previous surplus, $772,223, a total of $927,649. This compares with a surplus of $772,223 for the previous year. At the annual meeting of the company H. S. Kerbaugh was elected a director to succeed Edward D. Toland. The other directors were reelected.

Chicago:	*Closing.*
Chicago Telephone	101
Chicago Edison Light	145
Metropolitan Elevated preferred	68
National Carbon common	91½
National Carbon preferred	122½
Union Traction common	5
Union Traction preferred	15

OBITUARY NOTICES.

MR. ROBERT E. DRAKE, general counsel of the Niagara, Lockport & Ontario Power Company, was killed by a railroad train on Saturday evening, April 21. Mr. Drake was also a director of the power company.

MR. H. J. W. DAM, a well-known newspaper man, died in Havana, Cuba, on Thursday, April 26. Mr. Dam was a native of San Francisco, Cal., a graduate of the University of California, and was at one time executive secretary to Governor Stoneham. He achieved considerable recognition as a writer and playwright, several of his plays having had long and successful runs. In the technical field Mr. Dam contributed a number of highly interesting articles relating to celebrities and also concerning investigations into the lost arts. He was a man of very genial disposition, and was held in great affection by men in every walk of life. His friends in the electrical fraternity, where he possessed many, will deeply deplore his death. He is survived by a widow and two sons.

MR. ROBERT J. SHEEHY died at the Post Graduate Hospital, New York city, on Thursday, April 26, in his sixty-fourth year. Mr. Sheehy was one of the very well-known electrical engineers and inventors whose careers started in the earliest days of electrical development, and whose versatility in invention gave him the name among his associates of "the prolific inventor." Mr. Sheehy was the inventor of the "Telotype," a printing telegraph system; an automatic signal system for electric and steam railways, an automatic system for third-rail electric railways, a multiple unit control system, an automatic sectionalizing system for power rails, an automatic electromagnetic graduated brake system, an automatic point locking and unlocking system, and a station selector telegraph system.

MR. HENRY E. HAWLEY, general manager of the Hudson River Telephone Company, died suddenly on Friday morning, April 27, at his home in Albany, N. Y. Mr. Hawley was one of the best-known citizens of Albany, and his sudden death was a great shock to a host of friends. Mr. Hawley was born in Troy, N. Y., August 16, 1862. He was educated in the public schools of Troy, and took a course at the Troy Business College. His first work was for the New York Central & Hudson River Railroad, at Troy, where he filled a clerical position. He was with the railroad company for three years, when he took a position in the John G. Myers store at Albany. He remained there until 1891, when he moved to Buffalo to take a position with Barnes, Hengerer & Company's drygoods establishment. Later he became connected with the telephone company, and was assistant to General Manager A. B. Uline, whom he succeeded on January 1, 1892. Mr. Hawley was a member of the Albany Club, the Troy Club and the Transportation Club, of New York. The funeral, which was held on Sunday afternoon, April 29, was attended by representatives of the different departments of the Hudson River Telephone Company and by a number of prominent telephone men from New York city.

EDUCATIONAL.

SUMMER COLLEGE FOR ARTISANS AT THE UNIVERSITY OF WISCONSIN—The sixth annual session of the summer school for artisans held under the direction of the College of Engineering of the University of Wisconsin, begins on June 25, continuing for a period of six weeks. Courses of study are offered in the following subjects: Engines and boilers, applied electricity, mechanical drawing and machine design, materials of construction, fuels and lubricants, shop work, and manual training. The instructional force is taken from the regular faculty of the College of Engineering, and the entire laboratory and shop equipment belonging to the college is used by the students in the summer school. The requirements for admission do not extend beyond a working knowledge of English and arithmetic. A bulletin describing the work will be sent on application to Frederick E. Turneaure, dean of the College of Engineering, Madison, Wis.

NEW INCORPORATIONS.

ST. PAUL, MINN.—Akeley Telephone Company. $15,000.

LINCOLN, NEB.—Silver Creek Telephone Company. $25,000.

MADISON, WIS.—Pulaski Telephone Company, Pulaski. $800.

BURLINGTON, VT.—Ryegate Light and Power Company. $25,000.

HARRISBURG, PA.—Bald Eagle Telephone Company, Howard. $15,000.

LINCOLN, NEB.—The Sargent Independent Telephone Company. $1,000.

WILKESBARRE, PA.—Pittston Light, Heat and Power Company. $150,000.

WILMOT, OHIO.—Valley Telephone Company. Increased from $1,000 to $5,000.

WARSAW, N. Y.—The village of Pike has voted to install an electric light plant.

GUTHRIE, OKLA.—College Corner Rural Telephone Company, of Hennessey. $400.

MADISON, WIS.—Brown County Telephone Company. Increased from $10,000 to $20,000.

CHICAGO, ILL.—North Shore Electric Company. Increased from $1,250,000 to $3,000,000.

LINCOLN, NEB.—Valparaiso Telephone Company. $25,000. Incorporators: A. C. Abbott and C. H. Wood.

LINCOLN, NEB.—Solon Telephone Company. $25,000. Incorporators: George B. Hendricks, A. M. Malone.

HARRISBURG, PA.—Albion Light and Power Company. $5,000. Directors: R. P. Flower, E. M. Flower and J. R. Flower.

PALESTINE, TEX.—The Palestine Electric Light Company has been granted a new franchise for fifty years, dating from April 9.

MADISON, WIS.—The Individual Telephone Company, Highland. $800. Incorporators: John J. Yerke, Joseph Richter and J. F. Lohrs.

JACKSON, MICH.—The Grass Lake & Sharon Telephone Company. $1,000. Directors: W. G. Alber, John Lemm and Ashley L. Holden.

GUTHRIE, OKLA.—Myrtle Rural Telephone Company, of Hennessey. $480. Incorporators: J. R. Fowler, W. D. Frakes and T. E. Howard.

LANSING, MICH.—The Thornapple Power and Electric Company, of Grand Rapids. Increase in capital stock from $1,000 to $100,000.

SIOUX FALLS, S. D.—Brookings & Sioux City Railway Company. To construct an electric line between Brookings and Sioux Falls. $100,000.

AUSTIN, TEX.—The Southwestern Telegraph and Telephone Company, of New York. Increase of capital stock from $7,000,000 to $10,000,000.

HARRISBURG, PA.—Dunbar Electric Company. To furnish electricity to the citizens of Fayette county, especially those of Dunbar. $5,000.

PHOENIX, N. Y.—The plant of the Phoenix Fuel, Light and Water Company has been sold to New York capitalists at a price said to be $150,000.

HOLDENVILLE, I. T.—William Dunn has placed in operation his new $250,000 electric light plant. The town has been in darkness for six months.

COLUMBUS, OHIO—Doe Run Telephone Company, Scio. $500. Incorporators: A. N. McCombs, H. W. Henderson, F. S. Edgar, W. B. Turney and W. N. Henderson.

MADISON, WIS.—La Crosse Hydro-electric Light and Power Company. Changed to La Crosse Water Power Company. Capital increased from $1,000,000 to $5,000,000.

AUSTIN, TEX.—Sulphur Springs & Peerless Telephone Company, of Sunny Slope, Hopkins county. $400. Incorporators: Henry

Hurley, Ed. B. Beck, W. T. Hardaway, A. L. Hurley, M. Pogue, T. E. Williams and Perry Conally.

LOS ANGELES, CAL.—Southern Nevada Light and Power Company. $150,000. Directors: U. S. G. Todd, George J. Dippe, J. A. McNabb, T. B. Wilkinson, B. F. Roehrig.

SPRINGFIELD, ILL.—Millstadt Telephone Company, Millstadt. $1,200. Incorporators: F. W. Krechner, S. C. Sauthof and A. C. Kern, George D. Bardon and N. Leonard.

MUSKEGON, MICH.—The Grand Rapids-Muskegon Power Company is preparing to put in a second 6,000-horse-power dam at Croton, Newaygo county, to cost $500,000.

AUSTIN, TEX.—Northwest Toll Line Company, of Dallas. To construct and operate telephone lines. $25,000. Incorporators: A. A. Miller, A. A. Marrs and L. J. Weaver.

MADISON, WIS.—The Attica Mutual Telephone Company, Attica, Green county. $10,000. Incorporators: Oliver S. Jones, Herbert E. Ludington and Chauncey T. Bartlett.

JEFFERSON CITY, MO.—California Telephone Company, of California. $9,000. Incorporators: T. J. Buchanan, A. W. Farnall, Fred Himpel, James L. Buchanan and others.

GUTHRIE, OKLA.—The Mountain Park Telephone Company, of Mountain Park. $5,000. Incorporators: W. W. Watson, C. E. Jecks, D. A. Giles, T. C. Moessner and J. C. Watson.

COLUMBUS, OHIO—Malinta Mutual Telephone Company, Malinta. $5,000. Incorporators: J. L. Rentz, P. Heckler, Jr., L. S. Hall, Frank Orthwein, W. M. Decks and Fred Hefflinger.

LANSING, MICH.—Grand Rapids-Muskegon Water-Power Electric Company. Changed to Grand Rapids-Muskegon Power Company. Increase of capital from $1,000,000 to $3,000,000.

KAUKAUNA, WIS.—The Kaukauna Gas, Electric Light and Power Company. $100,000. Incorporators: William W. Allis, Charles S. Carter and Charles E. Canright. Main office, Milwaukee.

RUTLAND, VT.—The Boltonville Electric Company. $25,000. Incorporators: M. F. Sargent, Robert Farquharson, George H. Roben, F. J. Tewksbury, James W. Cragie, C. H. Taplin and H. W. Goodine.

MINNEAPOLIS, MINN.—Beltrami Electric Light and Power Company, Bemidji. $50,000. Incorporators: W. G. Schroeder, C. W. Warfield, A. A. Warfield, Bemidji; C. F. Schroeder, Grant Valley; F. M. Schroeder, Lake Hattie.

ALBANY, N. Y.—South Hannibal Telephone Company. To operate between Hannibal, Granby and Bowens Corners. $1,800. Directors: P. A. Welling, Grant B. Wilson, Ernest W. Rice, George H. Wolvin, Walter C. Matteson.

GUTHRIE, OKLA.—Shattuck Electric Light and Power Company. $3,000. Incorporators: W. G. Sears, R. A. Moody and J. E. Wing, of Shattuck; W. P. Graham and O. M. Spencer, of St. Joseph, Mo.

LINCOLN, NEB.—The Bohemian Mutual Telephone Company. $600. Incorporators : J. K. Vlach, Frank Musil, Vaclav Vlach, J. V. Dostal, George Frie, Anton Karnik, Frank J. Hanzel, William Uher, V. J. Tichota, Frank Stecher and Sebasta Sladovnik.

HENDERSON, KY.—Evansville & Henderson Traction Company. $10,000. Incorporators: H. W. Richardson and J. E. Bohannon, of Louisville; A. L. Rich, of Cincinnati; C. C. Ennis, of Pittsburg; C. H. Butler, of Evansville; E. G. Reitman, of New Albany; J. Pritchard, of Evansville.

RALEIGH, N. C.—North Carolina Electric Company, of High Point. For the purpose of constructing interurban electric railways within a radius of fifty miles of High Point. $1,000,000. Incorporators: Dee Allen, of Condor, Montgomery county; Daniel G. Griswald, of Condor, and Melvin C. Hard, of Philadelphia.

PORTLAND, ME.—Continental Public Utilities Company. For the purpose of constructing, owning and operating electric plants and gas works for generating light, heat and power, and for other purposes. $12,500,000. Officers: President, Millard W. Baldwin, of Portland; treasurer, Clarence E. Eaton, of Portland.

HARTFORD, CONN.—The Tri-City Railway and Light Company. $1,000. Stockholders: Harry R. Tobey, J. Norris Miller, Harold Imbrie, Victor Innes, George H. Burritt, James T. Woodward, Harry S. Collette and Thomas C. Gillespie, all of New York city; Morris K. Parker, of New Canaan, Conn., and Edwin H. Hatch, of Maplewood, N. J.

CANTON, OHIO—Sandy Valley Telephone and Electric Company, of Alliance. $50,000. To operate an independent telephone system in the Sandy valley with centrals at Malvern, Waynesburg, Magnolia and other towns. Incorporators: A. S. Hillhouse, Morton Perdue, W. M. Welker, of Canton, and Ray S. Kaylor and Franzo D. Miller, of Alliance.

HUBBARD CITY, TEX.—The Union Central Light and Ice Company, of Hubbard City. To construct, equip, operate and maintain electric lighting and ice-making plants, etc. $35,000. Incorporators and officers: president and manager, W. August Bass, Hubbard City; first vice-president, J. E. Waller, Hubbard City; second vice-president, J. M. Carroll, Hubbard City; attorney, Hon. W. E. Spell, Hillsboro; architects and supervising engineers, Allen & Scott, Waco.

RALEIGH, N. C.—Greensboro & High Point Interurban Railway Company. To build a line or lines between Greensboro and High Point; High Point and Thomasville; Greensboro, Kernersville and Winston-Salem, or between High Point and Winston-Salem; Greensboro, Gibsonville and Burlington, or between Greensboro and any other town within fifty miles thereof. $300,000. Stockholders: W. D. Pender, E. W. Walcott, Henry K. Walcott and J. W. Perry, of Norfolk; James H. Dawes and H. B. Hodge, of Philadelphia.

VINCENNES, IND.—Vincennes Traction and Light Company. To operate traction lines in Vincennes, Bruceville, Bicknell, Oaktown, Freelandville, Decker, Monroe City, all in Knox county; Princeton, in Gibson county; Washington, in Daviess county; Carlisle and Sullivan, in Sullivan county; and interurban lines connecting such cities over public highways and through private fields; to supply electricity and steam for light, heat and power for the cities named. $200,000. Directors: Benjamin G. Hudnut, Terre Haute; Charles A. Gordon, Terre Haute; William Foley, St. Louis, Mo.; Morris Hudnut, Terre Haute; George Henry, Vincennes.

TELEPHONE AND TELEGRAPH.

TRUITT, VA.—The Camp Manufacturing Company has installed a telephone line from DeWitt to Franklin *via* Emporia.

TORONTO, CANADA—The Grand Trunk Railway has decided to spend $300,000 in equipping its lines with telephones.

ALBION, N. Y.—The Bell Telephone Company is about to place its wires and cables in underground conduits at a cost of $28,000.

NEWBURGH, N. Y.—The Hudson River Telephone Company has decided to erect a new line of poles along the Little Britain road.

MILTON, ORE.—The Milton Rural Telephone Company has elected the following directors: C. E. Simonds, William Forsythe, J. B. Saylor.

SPRINGFIELD, MO.—Springfield is to have a second telephone system. The Santa Fe Construction Company will invest $200,000 in a new plant.

SARATOGA SPRINGS, N. Y.—The Commercial Union Telephone Company is planning improvements to its local service which will double its capacity.

KEYSVILLE—The Southern Bell Telephone Company is securing right of way for a line from Danville to Richmond. A station will be erected in Keysville.

NEW ORLEANS, LA.—The Cumberland Telephone and Telegraph Company has let a contract for the construction of a new telephone exchange in Algiers.

CANON CITY, COL.—The Colorado Telephone Company has awarded the contract for its new telephone exchange. The building will cost, when complete, about $10,000.

BEAUMONT, TEX.—The annual meeting of the Beaumont Telephone Company was held recently and resulted in the reelection of the old board of directors and officers.

SPOKANE, WASH.—The Pacific States Telephone Company plans to spend about $50,000 in making its building on Wall street fire-

proof. The improvements will extend over a period of possibly a year.

JULESBURG, COL.—A deal has been consummated whereby the ownership of the Independent Telephone Company has been transferred to Cripple Creek and New York parties.

TERRE HAUTE, IND.—A mortgage for $1,000,000 has been filed by the Citizens' Independent Telephone Company to cover a loan with which extensive improvements are to be made.

WASHINGTON, D. C.—The secretary of the interior has authorized the advertisement for bids for a telephone system in the Strawberry valley country, Utah. About fifty stations will be put in.

CHARLESTON, ILL.—A company has been formed, with a capital of $1,500, to build a new country telephone line in Hickory and Morgan townships. H. L. O'Hair is president of the company.

BALTIMORE, MD.—The highways commission has granted four permits to the Chesapeake & Potomac Telephone Company to extend its lines along the roads near Eklo, Freeland, Mount Carmel and Beckleysville. These new lines will be built at once.

DAVENPORT, IOWA—A bill of sale has been filed with the county recorder in which the Davenport & Tipton Independent Telephone Company transfers to the German Mutual Telephone Company, of Clinton, Iowa, its rights in the town of Walcott.

READING, PA.—The Pennsylvania Telephone Company is preparing to do a great deal of work this spring and summer. Many distant points are being connected up. The latest rural line is a twenty-mile circuit terminating at the Boyertown exchange.

ERIE, KAN.—A deal has been closed by which the Erie Telephone Company has transferred all its telephone property in Neosho county to the Bell company. The exchanges at Erie, St. Paul and Stark were included in the sale, together with about 100 country lines.

LEADVILLE, COLO.—The Colorado Telephone Company is to install a new, modern and up-to-date telephone system in the Leadville district and will construct a new building for a telephone exchange. There will be a reduction of rates that will average about twenty per cent.

SIOUX CITY, IOWA—The Sioux City Telephone Company is installing 1,000 additional line selector switches at its exchange. The cost of the improvement will be $25,000. The company now has 2,500 telephones in operation, and the additional equipment will give it another thousand.

RUSHFORD, N. Y.—The Rushford Telephone Company has sold a controlling interest in the local system to the Inter-Ocean Telephone and Telegraph Company. The Bell Telephone Company has purchased a controlling interest in the Belfast Telephone Company and will soon install an all-night service.

CLARKSBURG, W. VA.—The Sardis Telephone Company has elected the following directors: J. W. Gerrard, Silas Starks, Alexander Davisson, Marion T. Cunningham, Lloyd M. Hustead, John Robey, A. J. Michael, Michael Morris and A. W. Coffman. J. W. Gerrard was elected president. The company has over 100 miles of lines and intends to extend to Adamston.

HUTCHINSON, KAN.—The Missouri & Kansas Telephone Company will soon begin the construction of a new pole and wire line from Hutchinson to Pueblo, and from there to Denver. This will make continuous telephone service possible from Denver to Boston, *via* Hutchinson. The new line from Hutchinson to Denver will be heavy copper wire and will cost about $400,000.

BESSEMER, ALA.—The North Johns Telephone Company, recently organized, has let the contract for the erection of a complete system. This line will connect with the Oak Grove and Short Creek lines, already in operation, and over a hundred of the prominent farmers and merchants in the lower end of Jefferson county and the upper end of Walker county will be in touch with each other.

RISING SUN, MD.—At the annual meeting of the Cecil Farmers' Telephone Company, the following board of directors was elected for the ensuing year: R. E. McClenahan, M. E. Kirk, R. K. Rawlins, Edward Dorcas, Elwood Balderson, A. L. Duyekinck, Joseph Groves, Cecil Ewing and Carlton Kimble. The company has been granted a charter whereby its capital stock is increased from $30,000 to $60,000.

UTICA, N. Y.—The new Bell telephone plant at Camden, which is now in course of construction and which will accommodate 500 subscribers, will be completed shortly after April 1. The Camden exchange will be up to date in every particular. Connecting with this exchange are several farmers' lines. The company will pay special attention to this branch of telephone development, and the farming section for some miles adjacent to Camden will be well supplied with telephones. The company has made an arrangement with the weather bureau to obtain weather forecasts.

JACKSON, MICH.—Within the next few weeks the Michigan State Telephone Company will begin the extension and improvement of the local service. This spring and summer 26,650 feet of aerial lines are to be added to the overhead system, and 6,835 feet of additional cable placed in conduits. In all, the company will spend $15,000 on local improvements. The new toll line between Jackson and Battle Creek is in service, as are the two recently-constructed lines between Jackson and Hudson. Springport, Rives Junction, Tompkins and tributary systems are now in direct communication with Jackson.

WILMINGTON, DEL.—The Delmarvia Telephone Company has consolidated with the Wilmington Electric Light and Power Company under the corporate title of the Wilmington Light, Power and Telephone Company, with a capital of $1,250,000. The Delmarvia Telephone Company has installed an automatic system and the electric light company was recently given a city franchise. The officers of the new corporation are: president, Charles C. Kurtz; vice-president, George R. Webb, Baltimore; secretary and treasurer, Stanley Baker; Horace W. Gause, Samuel K. Smith, Alfred L. DuPont and Henry P. Scott, additional directors.

SYRACUSE, N. Y.—General Manager Stevens, of the Central New York Telephone Company, states that thirty-eight miles of subway will be built in addition to about sixteen miles already constructed. Miles of cable will be strung. A contract has been let for cable to cost $100,000. Subways and cables will cost about $325,000. Three stories will be added to the new building in Montgomery street at a cost of $100,000. A distributing station is being built in Sand street at a cost of $35,000. Between 500 and 600 poles will be taken down. The total expenditures of the company in Syracuse will be approximately $460,000.

HILTON, N. Y.—At a recent meeting of the stockholders of the Hilton Telephone Company, it was voted not to sell the plant to the Bell Telephone Company, but to increase the amount of the capital stock from $8,000 to $15,000. At a meeting of the directors held immediately after the stockholders' meeting, the president and manager, John E. Cooper, was given power to sell such proportion of the new stock as he thought advisable from time to time, and also to enlarge the plant and extend the lines. An additional switchboard and other improvements will be added to the central office, and active operations will soon be begun on the construction of new lines and the extension of others.

NEW MANUFACTURING COMPANIES.

BUFFALO, N. Y.—The Niagara Electric Sign Company has been incorporated. The capital stock is $5,000. The directors are William R. Huntley and George W. Ames, of Buffalo, and Joseph E. Montague, of Niagara Falls.

TRENTON, N. J.—The Excelsior Electric Protection Company has been incorporated with a capital of $200,000, to deal in electrical machinery. The incorporators are Harry A. Hood, Hampton De Ruth and Henry W. Phillips.

NEW PUBLICATION.

LOCATING FAULTS WITH THE WHEATSTONE BRIDGE—Herr Br. Böhm-Raffay has reprinted, in pamphlet form, his article entitled "Ueber Fehlerort-Bestimmung mit der Wheatstoneschen Brückenschaltung," which appeared in the *Elektrotechnischer Neuigkeits-Anzeiger und Maschinentechnische Rundschau, February* 15.

ELECTRIC RAILWAYS.

WILMINGTON, DEL.—The directors of the Wilmington City Railway Company have awarded contracts for new equipment which will cost about $400,000.

WOOSTER, OHIO—At a meeting of the Wooster city council a franchise was granted the Wooster-Mansfield Trolley Company. Construction will be begun soon.

COLUMBUS, GA.—A movement is on foot at Columbus and in Eufaula, Ala., to build an electric railroad from the former city to Dotham, Ala., *via* Eufaula and Abbeville, Ala.

CONCORD, N. H.—The contract for building the Hudson, Litchfield & Toff Falls Electric Railway has been let to the Hub Construction Company and work will be begun at once.

PORTLAND, ME.—At the office of the railroad commissioners in Augusta articles of association were filed for the organization of a company to build an electric railway on Cape Elizabeth.

CLEVELAND, OHIO.—The Cleveland, Akron & Columbus Railway Company has amended its charter so as to enable it to build a branch line from Rightmire to Millwood, in Knox county.

CLEVELAND, OHIO—The Cleveland & Southwestern Traction Company has placed an order for fifteen additional cars, and during the summer will expend $500,000 in improving its roadbed.

DES MOINES, IOWA.—General Manager Blake, of the Newton & Northwestern, has awarded the contracts for grading the new lines of his company between Des Moines and Kelley and Kelley and Ames.

HOOD RIVER, ORE.—It is the intention of the Mount Hood Railroad Company to extend its line up the valley to Mount Hood settlement and later to the base of the mountain. Electricity will be the motive power.

ROCHESTER, N. Y.—J. G. White & Company have resumed work on the construction of the Rochester, Syracuse & Eastern Road between Rochester and Lyons and it is expected cars will be running on this section of the line early in the summer.

HARRISONVILLE, KY.—The Fiscal Court of Shelby County has granted a right of way over the Shelby turnpike to the Louisville & Eastern Railroad for the construction of an electric line from the fair grounds to the city limits at Shelbyville.

TRENTON, N. J.—The Galvin franchise tax bill, which passed in the senate without a dissenting vote, requires trolley companies to pay a tax of two and one-half per cent on their gross receipts this year and one-half per cent additional each year until the rate reaches five per cent.

FREDERICK, MD.—Work on the extension of the Frederick & Middletown electric road from Frederick to Unionville, a distance of fifteen miles has been begun. The link from Frederick to Unionville by the way of Liberty is to be the first in the building of the electric road between Frederick and Baltimore.

TACOMA, WASH.—General Manager W. S. Dimmock, of the Tacoma Railway and Power Company, has announced that his company will build an electric interurban railroad between Olympia and Tacoma. This will be done by the extension of the prospective trolley line from Tacoma to American Lake on to Olympia. Work is soon to be begun.

BURLINGTON, IOWA—An electric line connecting Burlington with Columbus Junction is being projected and an interurban company to construct the line has been organized. The officers elected were: H. A. Aubler, Mount Pleasant, president; O. P. Wilcox, Columbus Junction, vice-president; E. C. Hinkle, Winfield, secretary; J. E. Peterson, New London, treasurer.

UPPER SANDUSKY, OHIO.—A franchise has been granted by the council to John J. Barber, a Toledo capitalist, representing the Findlay, Carey, Upper Sandusky & Marion Electric Railway Company, to construct a line through Upper Sandusky, connecting with the Marion-Columbus line at Marion and the Toledo-Findlay line at Findlay. The line is to be completed by next January.

SIOUX CITY, IOWA—An important meeting of bankers, farmers and representatives of commercial organizations from points between Sioux City and Spirit Lake was held at the rooms of the Sioux City Commercial Club recently to consider building an electric line from Sioux City to Spirit Lake. It was the sentiment of the fifty men present that the line should be built, and that a company should be incorporated.

GRAND RAPIDS, MICH.—The Grand Rapids-Muskegon Power Company has closed a contract with the Holland interurban to furnish the latter with power June 1. The power company will deliver the current to the interurban line at Jenison, giving 1,500 horse-power daily. This is the capacity of the latter's plant at Jenison, and the power company takes over this plant and will operate it as an auxiliary.

OROVILLE, CAL.—The North Electric Company has let the contract for the grading of the extension of its electric line between Oroville and Marysville. The line at present extends as far north as Chico, and the grading, which will be completed by August 1, will be followed by the laying of rails and stringing of wires by the company. The company then expects to have the road from Chico to Marysville open by January 1 of next year.

CLEVELAND, OHIO—Work on the new Cleveland-Alliance electric road, to parallel the Pennsylvania, will be begun shortly, according to its promoter, James W. Holcomb. Seven-eighths of the fifty-foot right of way between the two cities has been obtained. The only franchise lacking is that through Ravenna. The road will cost about $1,750,000 and will be completed within three years. It will be known as the Cleveland & Alliance Electric railroad.

WATERTOWN, WIS.—The engineers of the Milwaukee Heat, Light and Traction Company, which has been granted a franchise to operate a line in Watertown, have received orders to begin a permanent survey of the proposed route from Watertown to Johnson Creek, Jefferson and Fort Atkinson. This is in conjunction with the work which will be pushed from Oconomowoc to Watertown this summer. It is expected now that the line south will be completed in less time than three years.

CENTRALIA, ILL.—The directors of the Centralia & Central City Traction Company held a meeting recently and completed reorganization by electing J. D. P. Francis, of St. Louis, president; W. W. M. Warner, vice-president, and H. M. Warner, treasurer. The stock of the old company was taken up and new stock issued. The road has been operated as a mule line for fourteen years, but material is now being received to build a modern trolley system. The controlling interests are now held by St. Louis capitalists.

FORT WAYNE, IND.—The Fort Wayne & Wabash Valley Traction Company, which is extending its electric lines from Logansport to Lafayette, has incorporated for this purpose under the name of the Lafayette & Logansport Traction Company, of Fort Wayne, with a capital stock of $500,000. The documents state that the line will touch at Lafayette, Buck Creek, Colburn, Delphi, Rockfield, Burrows, Clymers and Logansport. The route as thus mapped out will parallel the Wabash railroad between Logansport and Lafayette.

YORK, PA.—It has been announced that the control of the York County Traction Company has passed into the hands of Brown Brothers, bankers, of New York. Grier Hersh, a director of the local traction company, now president of the Maryland Trust Company, of Baltimore, engineered the deal. The entire trackage of the system is fifty-six miles. In addition to the railway lines the York County Traction Company controls the Edison Electric Light Company, the Westinghouse Electric Light Company and the York Steam Heating Company.

SAN DIEGO, CAL.—An important transfer of railway and electric lines, involving $546,000, has been recorded. All the interests of E. S. Babcock in San Diego, consisting of trolley lines and a steam railway to La Jolla have been made over to the Los Angeles & San Diego Beach Railway Company, the Huntington interests, and the announced intention of the corporation is to construct electric lines from Los Angeles to Tia Juana, on the Mexican border. This transaction confirms the rumors of the past year, that Huntington proposes to connect Los Angeles and San Diego by trolley, and it is for this purpose that thousands of acres of watershed have been purchased along the San Luis Rey river and at other points between San Diego and Los Angeles.

INDUSTRIAL ITEMS.

THE H. B. CAMP COMPANY, New York city, has removed its office to the Flat Iron building, Fifth avenue and Twenty-third street.

THE BLISS ELECTRIC CAR HEATING COMPANY, Milwaukee, Wis., has issued a handsome bulletin descriptive of belt-driven equipment for passenger cars.

W. H. CRUMP & COMPANY, Chicago, Ill., announce the removal of their office to No. 1041 First National Bank Building. The new telephone number will be Central 3680.

THE AMERICAN VITRIFIED CONDUIT COMPANY, New York, N. Y., announces the removal of its office to the Fuller building, Broadway, Twenty-third street and Fifth avenue.

THE WISCONSIN BRAKE AND ELECTRIC COMPANY, the successor to the National Electric Company, Milwaukee, Wis., announces the removal of its offices from Milwaukee to 519 National Bank building, Chicago, Ill.

JAMES McCREA & COMPANY, 67 West Washington street, Chicago, Ill., have published a handsome catalogue descriptive of pipe repairs and steam specialties. Special attention is called to the "Cimax" steam joint clamp for pipe joint repair work.

THE ELECTRIC MACHINERY COMPANY, Minneapolis, Minn., has ready for distribution its bulletin No. 21, descriptive of direct-current multipolar generators for direct-connection to high-speed engines. These machines range from one and one-half to fifteen kilowatts in capacity.

THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has opened temporary offices at 67 Blake Block, Oakland, Cal. Several carloads of electrical apparatus have already left Pittsfield, to take the place of machinery damaged or destroyed in the California disaster.

THE FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind., has issued some new advertising literature. Flier No. 4,504 describes and illustrates porcelain primary fuse box, type EP; instruction book No. 3,023, type K, multiphase induction integrating watt-meters; bulletin No. 1,073, multiphase revolving-field belted generators.

THE BRISTOL COMPANY, Waterbury, Ct., will be pleased to send bulletin No. 39, listing Bristol's patent steel belt lacing, upon request. This price-list contains information concerning several new sizes which the company has recently commenced to make. The circular gives the list in a condensed and tabular form, enabling one to see at a glance the relation which exists between the different styles and sizes.

THE AMERICAN INSTRUMENT COMPANY, Newark, N. J., has recently issued Bulletin No. 52, which describes a new line of switchboard volt-meters and ammeters that must appeal very strongly to engineers and others who appreciate really high-class workmanship. The instruments represent new features of importance, and thorough investigation is invited. A copy of the bulletin can be obtained from James G. Biddle, general sales agent, 1114 Chestnut street, Philadelphia.

THE ELECTRIC CONTROLLER AND SUPPLY COMPANY, Cleveland, Ohio, has issued the initial bulletins of a series which it is to distribute throughout the field. These bulletins, Nos. 101 and 102, describe, respectively, "Dinkey" ventilated controllers and type "U" controllers. The bulletins are assembled in very convenient form, the illustrations and text are well printed, and the information appears to be so complete that nothing could possibly have been omitted. These bulletins should be very valuable to any one interested in this subject.

THE EDISON MANUFACTURING COMPANY, Orange, N. J., has published a booklet entitled "Battery Sparks for Gas and Gasoline Engine Users." This describes the Edison primary battery and spark coil for sparking gas engines. The subject is taken up in detail, and figures are given showing the comparative cost of sparking engines with Edison cells, dry cells and other classes of batteries. The Edison spark coil is wound with shorter and heavier wire, and transfers a very large proportion of the battery energy to the gas engine cylinder.

THE CENTRAL ELECTRIC COMPANY, Chicago, Ill., has recently sent out to its trade, a new price-list and discount sheet dated April. This price-list applies to the company's 1906 general catalogue No. 24 and contains the latest prices in force on all electrical material. Special attention is called to the fact that new prices are quoted on D. & W. enclosed fuses and safety devices for which the Central Electric Company are general western agents. This price-list should be in the hands of every purchaser of electrical material and any buyer who has not received a copy should write for one.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., has received recently, among other switchboard orders, one for a thirty-five-panel, 2,200-volt switchboard, to be installed at Crystal City, Mo., at the new plant of the Pittsburg Plate Glass Company. The city of Aurora, Ill., has contracted with the company for a 300-kilowatt, two-phase, alternating-current generator and 300 series enclosed, alternating arc lamps for its new municipal lighting plant. The Illinois Steel Company has recently purchased from the Western Electric Company a 400-kilowatt, direct-current generator, which will be installed at its north works, Wabansia avenue and McHenry street.

STANLEY & PATTERSON, INCORPORATED, has established new quarters at 23 Murray street and 27 Warren street, New York city. The store is 200 feet deep, and runs through from block to block. Goods will be received at one end of the store and shipped at the other. The building has been leased for ten years and will be fitted up so as to make the establishment as nearly a model electrical supply store as there is in the country. The factory has about doubled its capacity by taking in an additional building. Stanley & Patterson now manufactures the following well-known lines: "Faraday" pivoted armature skeleton bells; "Faraday" enclosed-type weatherproof bells; "New Code" receptacles and sockets; "Matchless" electric flashlight novelties, and "Fielding" sectional mica plugs and receptacles.

THE AMERICAN CONDUIT COMPANY, Los Angeles, Cal., announces the removal on May 1, 1906, of its Chicago offices to more central and more commodious quarters in the Marquette building, where Mr. A. L. Waterbury, general manager of the sales department, will be glad, as in the past, to receive the friends and patrons of the company, and where all inquiries by mail or otherwise will receive prompt and careful attention. The increase in the business of the American Conduit Company is decidedly gratifying, and gives satisfactory evidence, both by the volume of business and the class of customers served, that the merits of bituminized fiber conduit as an underground conduit have had practical demonstration and are being accepted with rapidly increasing favor.

THE GEORGE H. GIBSON COMPANY, Park Row building, New York city, which conducts the advertising of a number of leading machinery manufacturers, has recently taken up the subject of advertising inventions. Valuable inventions often lie dormant or are stolen because of the inventors lacking the time, opportunity or business ability and acquaintance which would enable them to dispose of their inventions profitably. The members of this organization are engineers with practical experience in civil, mechanical, mining and electrical work, and are in a position to act as commission agents in the selling of inventions, and make a point of using personal representation and correspondence in bringing about a sale. The company's clients' inventions are presented in a bulletin entitled "Engineering and Manufacturing."

THE BALL ENGINE COMPANY, Erie, Pa., announce the following recent orders: Fruit Growers' Refrigeration & Power Company, Anna, Ill., one 200 horse-power engine; Central Ice Company, Mounds, Ill., two 150 horse-power simple engines; National Tube Company, Pittsburg, Pa., one 700 horse-power cross-compound Corliss engine; Burnham Brothers, Milwaukee, Wis., one sixty horse-power simple engine; Oliver Mining Company, Hibbing, Mich., four 100 horse-power single cylinder engines; James W. Ellsworth & Company, Cleveland, O., two 400 horse-power simple engines; Erie County Electric Company, Erie, Pa., one seventy horse-power center-crank engine; Norristown Electric Light and Power Company, Norristown, Pa., one 400 horse-power single cylinder engine; Worcester Polytechnic Institute, Worcester, Mass., one 350 horse-power vertical cross-compound engine; Young & Summers, Lima, O., one 350 horse-power horizontal cross-compound engine.